Anadromous Fish Agreements and Habitat Conservation Plans

Final Environmental Impact Statement for the Wells, Rocky Reach, and Rock Island Hydroelectric Projects

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Summary

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SUMMARY

S.1 Proposed Action

The U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS) is evaluating the decision to authorize incidental take permits, in accordance with Section 10 (a)(1)(B) of the Endangered Species Act of 1973, for 50-year anadromous fish agreements and habitat conservation plans (HCPs) with two Washington State public utility districts (PUDs) for the Wells (Federal Energy Regulatory Commission [FERC] project number 2149), Rocky Reach (FERC project number 2145), and Rock Island (FERC project number 943) hydroelectric projects (67 Federal Register 42755 [June 25, 2002]). The HCPs were developed to protect five species of Columbia River anadromous salmonids (referred to as Plan species), two of which are currently listed as endangered under the Endangered Species Act.

The fish protection measures and methodologies proposed under the HCPs would also represent long-term settlement agreements under the Federal Power Act, Fish and Wildlife Coordination Act, Pacific Northwest Electric Power Planning and Conservation Act, Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act, and Title 77 Regulatory Code of Washington (RCW) for the five species.

The HCPs are consistent with the protocols and provision of the Basinwide Salmon Recovery Strategy "All-H Paper" (Federal Caucus 2000) and the reasonable and prudent alternatives contained in the biological opinion for the Federal Columbia River Power System (NMFS 2000a).

The agreements would set a "no net impact" standard for salmon and steelhead protection at three hydropower projects operated by the Chelan

and Douglas County PUDs and provide the PUDs with some degree of certainty for the long-term operation of these projects. Plan coverage of the three species not listed as endangered is expected to reduce the possibility that these species would be listed in the future.

The anadromous fish agreements and HCPs are the result of more than 9 years of planning and negotiations between the interested parties. In addition to NMFS and the PUDs, participants in the HCP development process were the U.S. Fish and Wildlife Service (USFWS), Washington Department of Fish and Wildlife (WDFW), the Confederated Tribes and Bands of the Yakama Indian Nation (Yakama), the Confederated Tribes of the Colville Reservation (Colville), and the Confederated Tribes of the Umatilla Indian Reservation (Umatilla) (collectively, the Joint Fisheries Parties); American Rivers, Inc.; and the major wholesale purchasers of the PUDs' electricity.

NMFS is the Federal agency responsible for protecting anadromous salmon and steelhead and is the lead agency for this National Environmental Policy Act (NEPA) final environmental impact statement (FEIS). The FERC is a cooperating agency for the purpose of developing the EIS, and the PUDs will coordinate compliance with the State Environmental Policy Act (SEPA).

The PUD No. 1 of Douglas County is applying for a permit covering the Wells Hydroelectric Project, and the PUD No. 1 of Chelan County is applying for permits to cover the Rocky Reach and Rock Island hydroelectric projects. The permit applications are based upon the HCPs and their exhibits and supporting documents.

The incidental take permits would provide coverage for four Permit species:

- 1. Upper Columbia River spring-run chinook salmon (*Oncorhynchus tshawytscha*),
- 2. Upper Columbia River summer/fall chinook salmon (*O. tshawytscha*),
- 3. Okanogan River and Lake Wenatchee sockeye salmon (*O. nerka*), and
- 4. Upper Columbia River steelhead (O. mykiss).

Currently, Upper Columbia River steelhead and spring-run chinook salmon are listed as endangered under the Endangered Species Act. During the species status evaluations, NMFS and USFWS determined that these Evolutionarily Significant Units represented the last of the remaining genetic resources of fish that migrated into the Upper Columbia River prior to the construction of Grand Coulee Dam. As a result, although these fish spawn in an area typically referred to as the Mid-Columbia River reach, they are designated as Upper Columbia River Evolutionarily Significant Units. For the purpose of this EIS, the Mid-Columbia River Reach is defined as the area of the river between the Chief Joseph Dam tailrace and the confluence of the Yakima River.

Although summer/fall chinook and sockeye salmon have not been listed, the Permits would

cover these species as well, according to the June 17, 1999 Federal policy governing the use of HCPs for the conservation of candidate or potential candidate species. The "No Surprises" policy associated with these agreements assures the PUDs that no additional measures would be required by NMFS for the duration of the Permits, for any of the Permit species.

Coho salmon (O. kisutch), an extinct species in the Mid-Columbia region, are also included in the HCPs as a Plan species. Recently, attempts have been made to reintroduce coho salmon into the area.

Although a Plan species, coho salmon are not considered a Permit species because an extinct species is not subject to Endangered Species Act jurisdiction. Thus, there are four Permit species and five Plan species covered by the HCP agreements.

The Columbia River bull trout populations were also listed as threatened under the Endangered Species Act in June 1998 (USFWS 1998). Because bull trout are not an anadromous species, this species is under the jurisdiction of the USFWS, rather than NMFS. The HCPs cover anadromous species under the jurisdiction of NMFS. However, bull trout are reviewed in this EIS to ensure that the HCPs' conservation measures do not negatively affect bull trout migration, breeding, cover, and resting areas.

S.2 PROJECT APPLICANTS

The project proponents are the following:

- The Douglas County PUD, a Washington municipal corporation, is sponsoring the Wells Anadromous Fish Agreement and HCP.
- The Chelan County PUD, a Washington municipal corporation, is sponsoring the Rocky Reach and Rock Island Anadromous Fish Agreements and HCPs.

The Chelan and Douglas County PUDs would file applications requesting FERC to amend their existing licenses to include the HCPs. In addition, the PUDs would rely upon the HCPs to fulfill their obligations for anadromous salmonids under new license agreements.

The HCPs would meet the Endangered Species Act requirements for the Permit species through the 50-year HCP terms. The Wells HCP becomes effective on the date that FERC adopts the HCP terms into the project license. The Rocky Reach and Rock Island HCPs would become effective on the date the last signatory party signs the agreements. If FERC does not relicense the projects, or issues a license inconsistent with the

conditions of the Permit and HCP, then NMFS may withdraw from the agreement and the Permit will not take effect. The applicants would then be obligated to meet Endangered Species Act requirements through Section 7 consultations.

S.3 PURPOSE AND NEED

The purpose and need for this project is to develop methods to protect anadromous salmonids in the Mid-Columbia River reach while allowing Chelan and Douglas County PUDs to continue to generate electricity to meet the power demands of the Pacific Northwest. The action alternatives considered in this EIS would result in:

- developing a comprehensive, long-term strategy for protecting and aiding in the recovery of anadromous salmonids in the Mid-Columbia River, two of which are currently listed as endangered under the Endangered Species Act;
- providing a process for managing fish passage issues for relicensing the three projects under the Federal Power Act;
- meeting applicable legislative requirements pertinent to the Endangered Species Act, including ensuring that any incidental take of listed species caused by the projects would not appreciably reduce the likelihood of the survival and recovery of the species it the wild;
- meeting NMFS's responsibilities under the Magnuson-Stevens Fishery Conservation Act to ensure the sustainability of the nation's fisheries resources;
- allowing the Chelan and Douglas County
 PUDs to plan for long-range operations with a
 degree of certainty to economically operate
 their projects and fulfill their long-term
 bonding and contractual sales obligations; and

 helping to ensure stable power supplies and pricing for the utilities' customers.

The project need is based on the substantial population decline of anadromous salmonids since European settlement of the Columbia River Basin. This decline is due (1) loss, destruction, or degradation of tributary habitat; (2) overharvest, genetic introgression, and competition with hatchery-reared fish; and (3) habitat inundation, blockage, and mortality from construction and operation of dams and reservoirs. Increased survival of all life stages of anadromous fish within the Columbia River Basin is necessary to meet the dual goals of recovering Endangered Species Act-listed anadromous fish and providing self-sustaining, harvestable populations of anadromous salmonids. The Wells, Rocky Reach, and Rock Island hydroelectric projects have affected anadromous salmonid populations through inundation of mainstem spawning and rearing habitat, decreased survival of migrating juveniles as they pass the projects, and possibly by decreasing survival or spawning success of migrating adults.

Since the projects were constructed, the applicants have worked (often in cooperation with other resource managers) to improve fish passage survival through facility and operational improvements and mitigate for project effects by funding hatcheries. Under the current licenses and agreements, each of the three projects has unique mitigation, compensation, and species protection requirements. However, a coordinated, comprehensive approach with similar performance survival standards among the three dams is currently not in place. Because the projects occur in the same geographical area

(whereby the reservoirs of the downstream projects encroach on the tailraces of the upstream projects) and operationally affect each other through changes in water quality parameters, a comprehensive cooperative approach among the projects would help to minimize fish losses and enhance fish passage opportunities in the Mid-Columbia reach.

S.4 Project Location

The Wells, Rocky Reach, and Rock Island hydropower projects are part of an 11-dam system on the mainstem Columbia River within the continental United States. Their location relative to the other projects in the region is shown in Figure S-1. Most of the projects on the mainstem Columbia River are Federally operated, although local PUDs operate five of the projects in the Mid-Columbia River segment. In addition to the three projects operated by the Chelan and Douglas County PUDs, the PUD No. 2 of Grant County operates the Priest Rapids and Wanapum dams (Priest Rapids Project).

The Douglas County PUD operates the Wells Project located at river mile 515.8 on the Columbia River, north of the City of Wenatchee. Wells began commercial operations on August 22, 1967, and is operated under a license issued by FERC, which expires in the year 2012.

Chelan County PUD operates the Rocky Reach and Rock Island hydroelectric projects. Rocky Reach Dam is located about 8 miles upstream from the City of Wenatchee, at river mile 474.5. The Federal Power Commission issued the original operating license for Rocky Reach on July 11, 1957. The license expires in 2006. Rock Island, which was the first hydroelectric project to span the Columbia River, is located about 13 miles downstream from the City of Wenatchee at river mile 453.4.

Rock Island began operating in 1933, and its operating license expires in the year 2028.

The project boundaries include the forebay (from the dam to approximately 500 feet upstream), tailrace (from the dam to approximately 1,000 feet downstream), and reservoir associated with each dam. The Wells reservoir extends approximately 30 miles upstream of the dam to the Chief Joseph Dam tailrace, the Rocky Reach reservoir extends approximately 41 miles upstream of the dam to the Wells tailrace, and the Rock Island reservoir extends approximately 20 miles upstream of the dam to the Rocky Reach tailrace. Considering all components of the three projects, the entire project area extends from the tailrace of the Rock Island Dam upstream to the tailrace of Chief Joseph Dam (approximately 92 miles). Some project effects, however, continue downstream through the Hanford Reach to the confluence of the Yakima River (inclusively defined as the action area). Project effects that continue downstream include water quality impacts (e.g., total dissolved gas levels) and delayed mortality of fish passing the projects.

All three of the hydroelectric projects discussed in this EIS are "run-of-the-river" facilities, which means that they have limited storage capacity compared to larger reservoir projects, such as Grand Coulee and Chief Joseph dams.

S.5 ALTERNATIVES CONSIDERED IN DETAIL

S.5.1 ALTERNATIVE 1 (No-ACTION)

Alternative 1 represents baseline conditions, which include the FERC licenses and

amendments that govern current operations. These licenses cover all aspects of dam operation, as well as environmental resource protection. Under Alternative 1, analyses in this EIS review how the licenses and the applicable amendments

affect the environmental resources within the project area.

Provided below are the protection measures associated with Alternative 1 that are pertinent to anadromous fish for direct comparison to Alternatives 2 and 3. The effects of these fish prescriptive measures on other environmental resources, (including resident fish), are described in Chapter 4 of this EIS.

S.5.1.1 Wells Hydroelectric Project

The original FERC license stipulated that two adult fishladders would be constructed at the Wells Project (adjacent to each embankment), as well as a low bucket spillway design that was approved by the State of Washington Department of Fisheries and Game (FERC 1962a). A subsequent amendment to the license stipulated a general requirement to provide mitigation for project construction, alteration, and operations, and to comply with reasonable requests to modify project structures and operations in the interest of fish and wildlife (FERC 1962b). Project structure revisions were approved in 1970 to comply with fishery agency requirements regarding fish ladder design and operation (FERC 1970). FERC (1982) amended the license to raise the forebay elevation by 2 feet.

In 1990, the Douglas County PUD, the Wells Project power purchasers, resource agencies, and tribes entered into a long-term fisheries settlement agreement regarding the Wells Project (FERC 1991). The 1990 Wells Settlement Agreement established the requirements for the Douglas County PUD to fund, operate, maintain, and evaluate three anadromous fish-related programs through at least March 1, 2004. These programs consist of: (1) juvenile downstream migrant fish passage measures, (2) adult passage measures, and (3) hatchery-based compensation measures for fish loss. These measures, in conjunction with existing hatchery compensation programs, were considered to fulfill Douglas County PUD's obligation to protect anadromous fish and

mitigate and compensate for the effects of the Wells Project on anadromous fish. The agreement also stipulates evaluation programs for fishery measures and establishes procedures for coordination among the PUD, its power purchasers, and the Joint Fisheries Parties through the Wells Coordinating Committee.

Section 7 consultation, pursuant to the provisions of the Endangered Species Act, has been completed for the interim protection plan involving the operation of the Wells Project (NMFS 2000b), although this coverage expired as of April 1, 2002. However, Douglas County PUD continues to operate the project in accordance with the 2000 biological opinion in anticipation that its HCP will be approved. Because these provisions have not formally been incorporated into the existing FERC license, they are not considered part of Alternative 1.

Juvenile Fish Passage

The juvenile fish passage program called for the installation and evaluation of a juvenile bypass system to route juvenile anadromous salmonids away from the turbine units. The established program uses controlled spill through modified spill bays to provide an effective non-turbine passage route through the project. The agreement includes specific operation, performance, and evaluation standards, as well as procedural guidelines for modifying the operational components of the system if necessary to meet the performance standards. The performance standards are set to provide fish passage efficiency (the percentage of fish bypassing the project through non-turbine routes divided by the total population of fish passing the project). The established fish passage efficiency standards are at least 80 percent during the juvenile spring migration period and at least 70 percent during the juvenile summer migration period.

Adult Fish Passage

The 1990 Wells Settlement Agreement called for evaluations of adult passage delay and mortality at the project beginning in 1991. If the evaluations identified delays or mortality, the agreement specified that operational modifications would be used to alleviate the problems. If those modifications could not correct the problems, the adult fishways would be modified.

Hatchery-Based Compensation

Under the 1990 Wells Settlement Agreement, the PUD agreed to fund a hatchery program to mitigate for fish passage losses at the Wells Dam. The agreement identifies specific production levels for the anadromous fish species affected by the project that are in addition to the existing mitigation program at Wells Dam. The agreement also provides the ability to adjust these additional compensation levels based on actual juvenile losses at the dam. However, production levels based on impacts of project inundation would not be altered. The agreement also establishes specific operational standards for the fish production facilities.

Measures Planned

The existing fish mitigation and compensation measures for the Wells Dam were developed through the 1990 Wells Settlement Agreement and subsequent agreements within the Wells Coordinating Committee. A summary of measures expected to either continue or be implemented under Alternative 1 are:

1. Adult Passage

- a. Continue operation and maintenance of the existing adult fishways.
- b. Investigate entrance and ladder modifications that may be necessary to

- improve ladder operations and minimize fish passage delay.
- c. Conduct appropriate evaluations to determine the best actions for correcting any significant delay.
- d. Develop solutions and implement corrective actions where adult passage problems are identified.

2. Juvenile Passage

- a. Surface Bypass Operation Operate at least one spillway bypass, throughout 80 percent of the peak spring and summer juvenile downstream migrations, respectively (Table S-1).
- b. Avian Predator Control As defined in the Cooperative Service Agreement between Douglas County PUD and the USDA Animal and Plant Health Inspection Service, this program is expected to continue at the Wells Dam and Wells Hatchery. Although it is a voluntary program, it is relatively inexpensive to conduct and effective at increasing juvenile fish survival through the project.
- c. Gas Abatement Control downstream total dissolved gas levels under total river flows up to the 7-day 10-year peak flow event to 120 percent of saturation. The 120 percent saturation criterion is a special exemption that only applies when the dam is spilling water to aid the downstream migration of fish. At all other times, the criterion is 110 percent of saturation.

TABLE S-1. SUMMARY OF EXISTING JUVENILE FISH BYPASS SYSTEMS AND SPILL OPERATIONS AT WELLS, ROCKY REACH, AND ROCK ISLAND DAMS (ALTERNATIVE 1)

PROJECT	BYPASS SYSTEM	PERIOD OF OPERATION				
Bypass Systems/Operations						
Wells	Surface bypass (baffled spill gates with discharge through controlled spill of up to 11% of total river discharge)	The Wells bypass team determines the timing of bypass operations of the bypass to cover at least 80% of the spring and summer juvenile anadromous fish migration timing. Fyke netting and hydroacoustics are used to help the bypass team make operational decisions regarding use of the bypass system.				
Rocky Reach	Turbine screens in two units; prototype surface bypass (discharge through conduit to tailrace)	24 hours/day between April and August. Construct a permanent bypass system ¹ before the 2003 migration and continue to evaluate and improve the efficiency of the bypass, and provide spill as an interim measure (see below)				
Rock Island	Passive gatewell orifice bypass system at Powerhouse 2 (discharges through a conduit to tailrace)	24 hours/day (spill is the primary bypass system used at Rock Island as described below)				
Spill Operations						
Wells	See bypass operations (above)	See bypass operations (above)				
Rocky Reach	15% of previous daily average flow in spring 10% of previous daily average flow in summer	30 days during spring migration, plus up to 6 extra days if necessary to encompass 90% of the run of Okanogan River sockeye				
		Total of 34 days between June 15 and August 15				
Rock Island	Spring and summer spill purchased by joint request of the Fisheries Agencies and Tribes from a Fisheries Conservation Account of \$2.05 million (1986 dollars adjusted for inflation) at the market price of energy	The Fisheries Agencies and Tribes decide when and how much spill to purchase based on funds available in the Fisheries Conservation Account				

¹ The construction and operation of the permanent bypass system has been consulted on by NMFS and authorized by FERC. However, because this system has been developed as a major component of the HCP, the effect of the new bypass structure is analyzed in the HCP alternative (alternative 3) rather than in the no-action alternative.

3. Hatchery Program

a. Continue to provide funding and hatchery capabilities to rear and release up to 49,200 pounds of spring-run chinook, 32,000 pounds of yearling summer chinook, 24,200 pounds of subyearling summer chinook, and 80,000 pounds of yearling steelhead, according to provisions in the settlement agreement. Sockeye production has been phased out because it has not lead to a substantial increase in adult returns. Approximately 15,000 pounds of spring-run chinook salmon would be substituted for the

- sockeye salmon production until 2005. After 2005, sockeye mitigation will be facilitated through the implementation of a set of flow management options that would increase the natural production of sockeye salmon in the Upper Okanogan River Basin.
- b. Under the settlement agreement, hatchery production for unavoidable losses could be reduced if survival studies indicate that fish passage mortality is less than the assumed 14 percent, which was the basis for the current mitigation level. Project survival studies indicate that for yearling

spring-run chinook and steelhead, actual project survival averages 96.2 percent. As a result, hatchery compensation would be reduced under Alternative 1 from the existing 14 percent to about 3.8 percent.

4. Monitoring and Evaluation

- a. Juvenile Run Timing Utilize hydroacoustic and fyke net monitoring data to determine the timing of bypass system operations.
- Survival Develop and utilize the best techniques to estimate the survival of juvenile salmon and steelhead passing the project. Techniques may include the use of mark recapture methodologies.
- c. Total Dissolved Gas Monitoring Monitor total dissolved gas levels and temperature at fixed location monitors in the forebay and downstream of the dam. Although this is a voluntary program, it is a program that is expected to continue given recent court rulings related to compliance with the Clean Water Act.
- d. Fish Counting Provide adult fish counts on a 24-hour basis.

S.5.1.2 Rocky Reach Hydroelectric Project

The existing fishery protection measures undertaken by the Chelan County PUD for the Rocky Reach Dam are the result of mitigation and compensation requirements in the original project license and subsequent amendments (FERC 1953, 1957a,b, 1968), as well as interim stipulations executed in the Mid-Columbia Proceedings (Docket No. E-9569 [FERC 1987b]). The interim stipulations were temporary agreements between the Chelan County PUD and the Joint Fisheries Parties with respect to juvenile fish passage measures and hatchery compensation

levels to mitigate for impacts resulting from project operations.

The first interim stipulation identified compensation and operational requirements that would be in effect from July 1, 1987 through August 31, 1988. Subsequently, the stipulation was extended and revised several times (FERC 1995, 1996a). The latest revision (Fourth Revised Interim Stipulation) was negotiated to include the period September 1, 1995 through December 31, 1997 (FERC 1996a). Although there is no current agreement for Rocky Reach, Chelan County PUD has continued to operate the project in coordination with the Mid-Columbia Coordinating Committee, as it has under the previous stipulations.

The Rocky Reach Dam has Section 7 Endangered Species Act coverage until 2006 through the biological opinion (NMFS 2002a) that was developed by NMFS in consultation with FERC for the construction and continued evaluation of the permanent juvenile fish bypass system.

Although the bypass option is a component of the Rocky Reach HCP, it was independently evaluated as part of a license amendment proceeding and was approved irrespective of future FERC actions on the HCP. Moreover, since construction of the permanent bypass system is not complete, the timing of its construction relates to the HCP, and represents a departure from the no-action condition. The bypass is therefore evaluated in this EIS as an HCP conservation measure under Alternative 3 (see Section 5.3.1 of the Rocky Reach HCP).

Juvenile Fish Passage

The main goal of the Fourth Revised Interim Stipulation was to develop a safe (less than 2 percent mortality) juvenile bypass system capable of bypassing 80 percent of the juvenile salmon and steelhead over 90 percent of the migration period. This agreement led to the development of a prototype surface bypass system that was installed at Rocky Reach Dam in the fall of 1994. Since that time, the bypass system has been modified based on the results of hydraulic modeling and fish passage evaluations. During development of the surface bypass system, the Fourth Revised Interim Stipulation provided a protection plan for juvenile migrants through the use of spill.

The prototype juvenile bypass system will be removed in the fall of 2002 and replaced with a permanent structure. Pile-driving activities required to construct the permanent bypass structure in the forebay have already begun. Completion of the permanent bypass system is expected to occur by the 2003 spring outmigration period. The regulatory approval to install the system was based on an environmental assessment and biological opinion. Since the bypass was approved, it is included under all the alternatives, but for reasons previously noted, it is evaluated under Alternative 3.

Adult Fish Passage

Under Alternative 1, Chelan County PUD would maintain and operate adult passage systems at the project according to the Detailed Fishway Operating Procedure criteria, or superior criteria developed through the use of specific study results of fish passage. The PUD would also operate the spill and turbine units in a manner that optimizes adult passage, while meeting requirements for juvenile passage. Adult and kelt steelhead fallback rates and kelt protection would be evaluated when implementing juvenile bypass options.

Hatchery-Based Compensation

Through the terms of the Fourth Revised Interim Stipulation, Chelan County PUD provides funding and hatchery capacity to compensate for anadromous fish production losses resulting from the initial inundation of the project. As with other portions of the stipulation, Chelan County PUD is expected to continue providing the same level of compensation under Alternative 1.

Measures Planned

Although the interim stipulation is expired, Chelan County PUD has continued implementation of the associated programs through the Mid-Columbia Coordinating Committee. In addition, NMFS has issued a biological opinion for the operation of the project and the construction of the juvenile bypass system (NMFS 2002a). This biological opinion provides specific measures for the protection of spring-run chinook salmon and steelhead, which were included in the license by amendment. The fish protection measures consistent with the Fourth Revised Interim Stipulation and the biological opinion (NMFS 2002a) include:

1. Passage

- a. Continue operation and maintenance of the adult fishways.
- b. Operate the powerhouse units within 1 percent of peak efficiency for a given head and power output, to the extent possible, and favor units 1 and 2 during the spring juvenile outmigration period.
- c. Construct a permanent juvenile bypass facility capable of bypassing 80 percent of the juvenile migrating salmon and steelhead over 90 percent of the migration period.

2. Gas Abatement

 Control downstream total dissolved gas levels under total river flows up to the 7day 10-year peak flow event to 120 percent of saturation.

3. Predator Control

- a. Continue to refine and implement a northern pikeminnow removal program.
- b. Continue avian predator control measures, as defined in the Cooperative Service Agreement between Chelan County PUD and the USDA Animal and Plant Health Inspection Service at the Rocky Reach Dam.

4. Hatchery Program

a. Continue to provide funding and hatchery facilities adequate to rear and release up to 54,400 pounds of fall chinook and 30,000 pounds of steelhead annually.

5. Spill Program

- a. Spill during the spring migration at a level equal to 15 percent of the daily average flow for 36 days, plus a potential additional 6 days spill at this level to provide additional protection for Okanogan River sockeye. During the summer, spill at a level equal to 10 percent of the daily average flow for a total of 34 days between June 15 and August 15 (see Table S-1).
- b. As indicated in the Juvenile Fish Passage section, the spill program at the project is currently being implemented in accordance with the HCP provisions and the biological opinion (NMFS 2002a). If the HCP is not approved, the spill program is expected to follow the guidelines of the Fourth Revised Interim Stipulation for non-listed fish species until the project license expires in 2006. The spill program for the listed species would follow the guidelines in the 2002 biological opinion through 2006. Because these spill measures are considered an integral component of the HCP, for the

purpose of comparison, they are analyzed under Alternative 3 (see Section 5.4.1c of the Rocky Reach HCP).

6. Monitoring and Evaluation

- a. Survival Develop and utilize the best techniques to estimate the survival of juvenile salmon and steelhead passing the project. Techniques may include the use of radio- or acoustic-tags or tag release and recapture methodologies.
- b. Total Dissolved Gas Monitoring –
 Monitor total dissolved gas levels and
 temperature at fixed location monitors in
 the forebay and downstream of the dam.
 Provide biological monitoring to
 determine the incidence of gas bubble
 disease symptoms in adult anadromous
 salmonids.
- c. Fish Counting Provide adult fish counts on a 24-hour basis.
- d. Steelhead Kelt Losses Assess the feasibility to study steelhead kelt losses through the project.

S.5.1.3 Rock Island Hydroelectric Project

The original FERC license for the Rock Island Dam was issued in 1930, and construction was completed in 1933. In 1987, the Chelan County PUD, Puget Sound Energy (formerly Puget Sound Power & Light), resource agencies, and Tribes entered into a long-term fisheries Settlement Agreement for the Rock Island Hydroelectric Project (FERC 1987a). The provisions in the Rock Island Settlement Agreement were included in the new license for the project in 1989 (FERC 1989a). The Rock Island Settlement Agreement was amended in 1993 to replace the requirement to conduct an adult fish mortality study with the requirement to

conduct an adult fish passage study (FERC 1993a).

The 1987 Rock Island Settlement Agreement established the requirements for the PUD to fund, operate, maintain, and evaluate three anadromous fish-related programs. These programs consist of: (1) juvenile fish passage measures, (2) adult fish passage measures, and (3) hatchery-based compensation measures.

Juvenile Fish Passage

The Rock Island Settlement Agreement called for a bypass development program to study, design, develop, test, and install a mechanical juvenile fish bypass system at the project. The performance standards targeted for the bypass system included achieving at least 80 percent fish passage efficiency during the spring migration period and at least 70 percent fish passage efficiency during the summer migration period. Subsequent efforts to develop an adequate mechanical solution to the juvenile bypass issue were unsuccessful. The PUD is currently evaluating modifications at the spillway to increase the rate of non-turbine passage at the project and utilizing a conservation account to provide spill.

As an alternative to juvenile bypass system development, the agreement established and the Rock Island Coordinating Committee chose to implement a Fisheries Conservation Account. This account (with an annual funding level of \$2.05 million in 1986 dollars, which is currently assessed at \$3.2 million) could be used by the fishery agencies and the Tribes to purchase spill as a means to increase the non-turbine passage of juvenile fish at the project.

Adult Fish Passage

Under Alternative 1, Chelan County PUD would maintain and operate adult passage systems at the project according to the Detailed Fishway Operating Procedure criteria, or superior criteria developed through the use of specific study results of fish passage. The PUD would also operate the spill and turbine units in a manner that optimizes adult passage, while meeting requirements for juvenile passage. The PUD would evaluate adult and kelt steelhead fallback rates and kelt protection when implementing juvenile bypass or spillway modification options.

Hatchery-Based Compensation

Under the Rock Island Settlement Agreement, the PUD agreed to construct, maintain, and fund a hatchery program to mitigate for fish passage losses at the Rock Island Dam. The agreement identifies the specific construction standards, production levels, and evaluation procedures to be implemented. The agreement also provides the ability to adjust these additional compensation levels based on actual juvenile and adult losses at the project, although production levels intended to compensate for project inundation would not be altered. The agreement establishes specific operational standards for the fish production facilities.

Measures Planned

The following fish protection measures were developed in the Rock Island Settlement Agreement and are included in Alternative 1:

- Modify the existing adult fishladders so their operation meets current fishery agency operating criteria.
- Utilize the conservation account to provide spill for spring and summer outmigrants, up to \$2.05 million (in 1986 dollars). However, as indicated in Section 2.2.3.1 (Juvenile Passage), the spill program at Rock Island Dam is currently being implemented in accordance with the HCP provisions (see Section 5.4.1a of the Rock Island HCP). If the HCP is not approved, the spill program is

expected to return to following the conservation account provisions contained in the Rock Island Settlement Agreement (see Table S-1).

- Continue to provide funding and hatchery capability to rear and release 250,000 pounds of salmon and 30,000 pounds of steelhead in a manner that is consistent with the maintenance of genetically distinct stocks.
- Evaluate fish guidance efficiency using hydroacoustic and direct capture methods, including assessments of injury and stress.
 Also review the hatchery programs (including sampling) to determine hatchery versus natural components of steelhead returns to evaluate hatchery production and its interrelationship with natural production.
- Gas Abatement Control downstream total dissolved gas levels under total river flows up to the 7-day 10-year peak flow event to 120 percent of saturation.
- Continue to refine and implement a northern pikeminnow removal program.
- Continue avian predator control measures, as defined in the Cooperative Service Agreement between Chelan County PUD and the USDA Animal and Plant Health Inspection Service, at the Rock Island Dam.

The following measures would apply for monitoring and evaluation:

- Total Dissolved Gas Monitoring Monitor total dissolved gas levels and temperature at fixed location monitors in the forebay and downstream of the dam. Provide biological monitoring to determine the incidence of gas bubble disease symptoms in adult anadromous salmonids.
- Juvenile Fish Passage System Continue to evaluate non-turbine juvenile fish passage

- options, as agreed to through the Rock Island Coordinating Committee.
- Fish Counting Provide adult fish counts on a 24-hour basis.

S.5.2 ALTERNATIVE 2 (HYDROPOWER CONSERVATION MEASURES TO PROTECT ANADROMOUS FISH)

Alternative 2 assesses additional anadromous fish conservation measures that could be implemented through the Federal Power Act and the Endangered Species Act while allowing the continued operation of the three projects. Under the Federal Power Act, new or revised conservation measures for anadromous fish could be required during license reopener proceedings or relicensing. Each of the three projects is scheduled for relicensing over the next 30 years with the Rocky Reach Project scheduled for relicensing in 2006, the Wells Project in 2012, and the Rock Island Project in 2028.

The opportunities to change conservation measures through license reopener clauses vary by project. Long-term settlement agreements have been reached for Rock Island and Wells dams that would limit some of the opportunities at these projects in the near term. However, there is no approved long-term agreement for Rocky Reach Dam, and relicensing procedures are currently underway to enhance the conservation measures for anadromous fish at that project.

Actions that would result in changes in conservation measures from existing conditions also include the potential for NMFS to request FERC to begin a proceeding under the reopener clause of the license and prepare a biological assessment on listed species due to a change in project operations, change in species status, identification of a species critical habitat that occurs in the project area, additional information related to project effects.

Due to a recent court decision, NMFS is currently reviewing the critical habitat designations for the Upper Columbia River Endangered Species Actlisted fish species. As a result, an additional consultation process might be required when a final critical habitat determination is made. If other species were listed under the Endangered Species Act in the future, additional consultation processes would also occur.

Under Alternative 2, compliance with the Endangered Species Act for the measures being considered by FERC is through the Section 7(a)(2) formal consultation process. With the assistance of each utility, FERC would provide NMFS with a biological assessment outlining the potential effects of the projects and any additional measures on listed species or their critical habitat (once designated)¹. A typical biological assessment would include the following information:

- a description of the action being considered;
- a description of the specific area that may be affected by the action;
- a description of any listed species or critical habitat2 that may be affected by the action;
- a description of the manner in which the action may affect any listed species or critical habitat1;
- an analysis of the cumulative effects; relevant reports and analyses prepared on the proposal; and any other relevant studies or information on the action, the affected species, or critical habitat1; and

¹ A recent court ruling has vacated the critical habitat designations for the listed anadromous salmon. Although consideration of habitat requirements would be assessed during consultation to determine whether the proposed action is likely to jeopardize the species, additional consultation might be required after critical habitat designations are finalized.

 an evaluation of how the action might adversely affect Essential Fish Habitat as defined under the Magnuson-Stevens Fishery Conservation and Management Act for chinook and coho salmon.

NMFS would then evaluate this information and any other information available to determine whether the proposed action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat¹. NMFS would then write a biological opinion describing their conclusions regarding the potential impacts of the proposed action on the listed species. At that time, NMFS would also fulfill its obligations under the Magnuson-Stevens Fishery Conservation and Management Act through an evaluation of the potential impacts of the proposed action on the Essential Fish Habitat of chinook and coho salmon.

Depending on their conclusions, NMFS could recommend additional protection measures to ensure that the proposed actions are not likely to jeopardize the continued existence of endangered species or result in the destruction or adverse modification of their critical habitat (once designated). Under this process, FERC would then have the responsibility of ensuring that measures identified in the biological opinion were implemented at the projects. The PUDs may either implement measures required by the biological opinion and FERC, or formally object to the mandatory requirements through litigation.

The protection of non-listed and anadromous species would be provided under the guidance of FERC. Although FERC and NMFS have not determined what, if any, additional measures would be required over the next 50 years to protect these species, it is likely that the agencies would require conservation measures that help to improve fish passage conditions at the projects and that do not result in adverse impacts to their habitat. However, the specific measures, the number of species covered, the proportion of the

migrants covered, and the implementation schedule are substantial uncertainties associated with this alternative.

S.5.2.1 Conservation Measures

Relying on past and recently completed consultations at other mainstem Columbia and Snake River hydroelectric projects, Alternative 2 conservation measures would likely include a combination of the following:

- measures that allow for increased upstream passage of adult fish through fishways and reservoirs and decreased fish injury and prespawning mortality (examples include hydraulic and structural fishway improvements—specifically, ladder modifications and improved attraction flow to help move fish more quickly into the ladder systems and past the dams); and
- measures that provide for increased downstream passage of juvenile anadromous salmonids while minimizing fish injury (examples include increased spill programs [in association with operational and structural modifications to reduce total dissolved gas levels], expanded predator control programs (fish and avian), the development of improved fish bypass systems, and potentially, drawdown or dam removal).

These measures may be directed at both listed and unlisted salmonid species and would possibly only occur during specific periods (seasonal) to benefit a particular life stage. The specific measures for listed species may be independent and may not necessarily benefit all salmonid species.

Each measure implemented under Alternative 2 would continue until such time that FERC or NMFS determines that:

• other protective measures would better increase survival.

- the proposed measures are determined to be ineffective or unsuccessful in increasing fish survival, or
- a Federally listed species is delisted and it is determined that previously approved protection measure may safely be relaxed or are no longer warranted.

The decision to apply specific measures at each dam would depend on the benefit of the measures to anadromous salmonids. It is envisioned that each dam would have a combination of juvenile bypass options, including a screened bypass and/or a surface bypass system, a spill program designed to maximize non-turbine passage, fish and avian predator control, and improvements to the adult facilities intended to maximize project and pre-spawning survival.

Initial survival standards for protection of listed species have been developed as a result of preliminary survival information and life-history analyses (draft Quantitative Analysis Report). The results of this life-history analysis is described in Chapter 5 and summarized in Appendix E.

S.5.2.2 Other Options Considered

If listed fish populations continue to decline, additional protection measures may be needed. Most of these additional measures would likely be in-water facility improvements.

Natural river drawdown is a remote possibility, and would have substantial environmental effects to many of the existing natural, physical, and social resources. However, this type of operation would help to mimic the natural river conditions that existed prior to the construction of the hydroelectric facilities, and thereby minimize the impacts caused by the hydropower system.

Although not recommended by a Federal, State, or local agency at this time, the review of natural river drawdown was requested by organizations

during public scoping for this EIS. Consequently, natural river drawdown at the three dams (Wells, Rocky Reach, and Rock Island) has been evaluated for Alternative 2 at a brief summary level to help understand and compare its effect with other conservation measures. Although natural river drawdown is not an option under the existing FERC licenses, it may be considered during relicensing for the projects if requested by interested parties (2006, 2012, and 2028 for the Rocky Reach, Wells, and Rock Island dams, respectively).

It is uncertain whether drawdown to minimum operating pool (seasonal reservoir drawdown), which is an option under the current licenses, would result in an increase in juvenile survival in the Mid-Columbia River. Although smolt migration rates would likely increase, the correlation between migration speed and survival has not been consistently documented (Giorgi et al. 2002). Therefore, it was not evaluated in this EIS.

S.5.2.3 Committees

It is uncertain whether implementation of measures developed through Alternative 2 would be conducted through the existing, or similarly structured, coordinating committees. However, a coordinating committee similar to those currently operating is expected to occur under this alternative. Alternative 2 would therefore include coordinating committees likely consisting of representatives of the Joint Fisheries Parties and the PUDs. Decisions by the committees are expected to continue to be made by consensus.

S.5.2.4 Conservation Measures at the Projects, Including Hatchery Programs

Wells Hydroelectric Project

In 1990, the Douglas County PUD, the Wells Project power purchasers, resource agencies, and

Tribes entered into a long-term fisheries settlement agreement for the Wells Project. This agreement established the Douglas County PUD's obligation for the installation and operation of juvenile downstream migrant bypass facilities, hatchery compensation for fish losses, and adult fishway operation. These measures, in conjunction with existing hatchery compensation programs, were considered to fulfil the Douglas County PUD's obligation to protect anadromous fish and mitigate and compensate for the effects of the Wells Project on anadromous fish.

Initial compensation was established at 14 percent until the PUD could implement juvenile survival studies to actually measure project impacts. Recent measures undertaken by Douglas County PUD, consistent with the now expired biological opinion on the Wells Interim Protection Plan (NMFS 2000b), would likely continue to be incorporated into a long-term fish recovery plan. Additional measures may also be sought by NMFS if project operations are likely to jeopardize the continued existence of the listed species or cause the destruction or adverse modification of critical habitat, or if there is not adequate potential for recovery of listed species.

Similar measures may also be implemented for non-listed species, although these measures would be approved through provisions in the Federal Power Act instead of the Endangered Species Act. As a result, there is potentially a lower likelihood of implementing the same measures for species that are not currently threatened or endangered.

Measures currently anticipated to be part of the protection program include:

- 1. Adult Passage In addition to the measures described under Alternative 1 for Wells Dam:
 - a. Operate the surface bypass system during the upstream adult steelhead and springrun chinook migration periods and during the downstream kelt passage period to

- maximize the survival of fallbacks and downstream migrating adults.
- 2. Juvenile Passage In addition to measures described under Alternative 1 for Wells Dam:
 - a. Operate within 1 percent of peak turbine power efficiency at all times during the juvenile and adult passage periods, with appropriate reporting and monitoring requirements to ensure compliance.
 - b. Operate the surface bypass system 24 hours a day for up to 99 percent of the juvenile migration period.
- 3. Hatchery Program The same amount of chinook, sockeye, and steelhead would be produced as described under Alternative 1, although production could be reduced because of the potential negative effects of hatchery fish on naturally spawning populations of Endangered Species Act-listed fish. In addition, Douglas County PUD would fund the changes in hatchery procedures and evaluations needed to make the hatchery compensation program consistent with the Endangered Species Act recovery goals for listed spring-run chinook salmon and steelhead populations. However, because of the potential effects of hatchery fish on natural populations, and considering that project-related mortality is 3.8 percent rather than the assumed 14 percent, hatchery production would be reduced under Alternative 2. A similar reduction would also apply to yearling summer-run chinook salmon.
- 4. Monitoring and Evaluation Measures are the same as described under Alternative 1 for juvenile run timing, survival, total dissolved gas monitoring, and fish counting. The following additional measures are expected to be implemented:

- a. Cumulative Effects In conjunction with NMFS, develop methodologies and conduct evaluations to assess the effects of passage through multiple dam systems on the fecundity, spawning success, and survival of adult spring-run chinook salmon and steelhead.
- Evaluate adult fishladder passage standards as they relate to spring-run chinook salmon and steelhead, and modify facilities as needed.
- c. Total Dissolved Gas Monitoring –
 Provide physical monitoring of total
 dissolved gas levels and temperature
 within the project area. Provide
 biological monitoring to determine the
 incidence of gas bubble disease symptoms
 in adult salmon and steelhead.

5. Spill Program

- a. Maximize use of the spill program up to the maximum allowable total dissolved gas levels. At Wells, this would likely include spilling up to 40 percent of the daily average flow for up to 99 percent of the juvenile migration season for each salmonid species to maximize fish passage efficiencies and survival. The timing of spill would likely range from April through August.
- b. Limit spill to ensure compliance with the Ecology total maximum daily load (TMDL) allotment for total dissolved gas, which is up to 120 percent of saturation for the tailrace and 115 percent for the forebay of the project.

FERC and NMFS may require additional measures based on information obtained from monitoring and evaluation. This would include the need to protect any listed species from jeopardy under the Endangered Species Act.

Rocky Reach Hydroelectric Project

Long-term protection measures for the Rocky Reach Dam would likely be similar to those described in biological assessments submitted to NMFS and the subsequent biological opinion for the construction and operation of the permanent bypass system (NMFS 2002a). Additional measures might also be necessary if project operations are likely to jeopardize the continued existence of the listed species or cause the destruction or adverse modification of critical habitat (once designated), or if there is not adequate potential for recovery of listed species, based on additional information available to NMFS and as a result of continued monitoring and evaluation.

Similar measures may also be implemented for non-listed species, although these measures would be approved and implemented through provisions in the Federal Power Act instead of the Endangered Species Act. As a result, there is potentially a lower likelihood of implementing the same measures for species that are not currently threatened or endangered.

Measures currently anticipated to be part of the fish protection program include:

- Adult Passage In addition to the measures described under Alternative 1 for Rocky Reach:
 - Enhance the fishway entrance attraction conditions through planned operation of spill gates and turbines.
 - b. Investigate ladder modifications to improve operations within specified standards and minimize fish passage delay.
 - Provide safe downstream passage facilities for adult fallbacks and kelts (e.g., bypass system operations, spill).

- d. Conduct modeling or other appropriate evaluations to determine the best actions for correcting passage problems, and implement measures as necessary.
- Juvenile Passage Measures in addition to those described in Alternative 1 would include:
 - a. Construct a permanent juvenile bypass system to NMFS criteria that maximizes the non-turbine passage of anadromous salmonids (although included in Alternative 1 it is evaluated under Alternative 3).
 - b. Operate turbine units within 1 percent of peak turbine power efficiency at all times during the juvenile and adult fish passage periods, with appropriate reporting and monitoring to ensure compliance.
 - c. Increase spill as necessary to maximize fish passage efficiencies and survival at the project.
 - d. Implement measures to ensure that total dissolved gas levels are maintained below 120 percent of saturation under total river flows up to the 7-day 10-year peak flow event.
 - e. Implement effective fish and avian predator control measures.
 - f. Potentially implement additional or alternative juvenile bypass systems, such as a surface bypass sluiceway, to improve fish passage survival.
- 3. Hatchery Program The same amount of chinook and steelhead would initially be produced as described under Alternative 1, although production could be reduced at any time because of the potential effects of hatchery fish on natural populations. Hatchery production of non-listed species would not be changed unless the production

levels are determined to affect the listed species. In addition, fund the changes in hatchery procedures and evaluations needed to make the hatchery compensation program consistent with recovery of spring-run chinook salmon and steelhead populations.

- 4. Monitoring and Evaluation In addition to those measures described under Alternative 1:
 - a. Cumulative Effects In conjunction with NMFS, develop methodologies and conduct evaluations to assess the effects of passage through multiple dam systems on the fecundity, spawning success, and survival of adult spring-run chinook salmon and steelhead.
 - Survival Utilize the best techniques to estimate the survival of salmon and steelhead through the project. Techniques would likely include the use of PIT-tags for juveniles and radio-telemetry methodologies for adults.
 - c. Total Dissolved Gas Monitoring –
 Conduct physical monitoring of total
 dissolved gas levels and temperature
 within the project area. Conduct
 biological monitoring to determine the
 incidence of gas bubble disease symptoms
 in juvenile steelhead and salmon.
 - d. Fish Counting Provide adult fish counts on a 24-hour basis.
 - e. Evaluate adult fish passage efficiencies through radio-telemetry studies.
 - f. Install adult PIT-tag detection devices in the adult fishways.

5. Spill Program

a. Maximize use of the spill program for up to 40 percent of the daily average flow for up to 99 percent of the juvenile migration season for each salmonid species to

- increase juvenile fish passage survival at the project. The timing of spill may therefore range from April through August.
- b. Limit spill to ensure compliance with the Ecology total maximum daily load allotment for total dissolved gas, which is up to 120 percent of saturation for the tailrace and 115 percent for the forebay of the project.

FERC and NMFS may require additional measures based on information obtained from monitoring and evaluation. This would include the need to protect any listed species from jeopardy under the Endangered Species Act.

Rock Island Hydroelectric Project

Long-term protection measures for the Rock Island Dam would include:

- Adult Passage In addition to the measures described under Alternative 1 for Rock Island:
 - a. Provide safe downstream passage facilities for adult fallbacks and kelts (e.g., bypass system operations, spill, etc.).
 - Evaluate passage facilities through hydraulic evaluations and adult passage studies and correct problems when identified.
 - Investigate ladder modifications to improve operations within specified standards and minimize fish passage delay.
 - d. Conduct evaluations on spawning success and fecundity as it relates to passage through a multiple dam system.

- 2. Juvenile Passage Measures in addition to those described under Alternative 1 would likely include:
 - Construct a permanent juvenile bypass system to NMFS criteria that maximizes the non-turbine passage of juvenile salmonids.
 - b. Operate turbine units within 1 percent of peak turbine power efficiency at all times during the juvenile and adult passage periods, with appropriate reporting and monitoring to ensure compliance.
 - c. Increase spill as necessary to maximize fish passage efficiencies and survival at the project.
 - d. Implement measures to ensure that total dissolved gas levels are maintained below 120 percent of saturation under total river flows up to the 7-day 10-year peak flow event.
 - e. Implement effective fish and avian predator control measures.
- 3. Hatchery Program The same amount of chinook and steelhead would initially be produced as described under Alternative 1, although production could be reduced because of the potential effects of hatchery fish on natural populations. Hatchery production of non-listed species would not be changed unless these production levels are determined to affect the listed species. In addition, fund the changes in hatchery procedures and evaluations needed to make the hatchery compensation program consistent with recovery of spring-run chinook salmon and steelhead populations.
- 4. Monitoring and Evaluation In addition to those measures described under Alternative 1:
 - a. Cumulative Effects In conjunction with NMFS, develop methodologies and

- conduct evaluations to assess the effects of passage through multiple dam systems on the fecundity, spawning success, and survival of adult spring-run chinook salmon and steelhead.
- Survival Utilize the best techniques to estimate the survival of salmon and steelhead through the project. Techniques would likely include the use of PIT-tags for juveniles and radio-telemetry methodologies for adults.
- c. Total Dissolved Gas Monitoring –
 Provide physical monitoring of total
 dissolved gas levels and temperature
 within the project area. Provide
 biological monitoring to determine the
 incidence of gas bubble disease symptoms
 in juvenile salmon and steelhead.
- d. Fish Counting Provide adult fish counts on a 24-hour basis.
- e. Evaluate adult fish passage efficiencies through radio-telemetry studies.

5. Spill Program

- a. Maximize use of the spill program for up to 40 percent of the daily average flow for up to 99 percent of the juvenile migration season for each salmonid species. The timing of spill may therefore range from April through August.
- b. Limit spill to ensure compliance with total maximum daily load allotment requirements, which is up to 120 percent for the tailrace and 115 percent for the forebay of the project.

FERC and NMFS may require additional measures based on information obtained from monitoring and evaluation. This would include the need to protect any listed species from jeopardy under the Endangered Species Act.

S.5.2.5 Adaptive Management

Alternative 2 includes an adaptive management component through the Section 7 re-consultation process. Re-consultation would occur if new information becomes available that indicates that the provisions of the initial consultation were not adequate to ensure the continued existence of the listed species. Re-consultations would also occur as a result of relicensing and license amendment processes, where FERC consults with NMFS prior to making a decision on proposed modifications of the project structures or operations or other plans that may affect listed species.

In addition, any actions that would substantially change conservation measures from existing conditions might have the potential for NMFS to request FERC to begin license reopener clause proceedings and prepare a biological assessment on listed species due to a change in project operations. Re-consultation would also occur if there were a change in species status, identification of a species critical habitat that occurs in the project area, or additional information related to project effects.

During re-consultation, NMFS would have the opportunity to adjust conservation measures, thereby providing an adaptive management process. However, there is some uncertainty of how effective this adaptive management process would be, given the potential implementation delays in the consultation process, and the project-by-project and issue-by-issue nature of the consultation process. This adaptive management would also involve just the listed species.

For unlisted species, adaptive management would involve the use of NMFS's Federal Power Act authorities to pursue additional protective measures in future relicensing or license reopener procedures or amendment proceedings. Adaptive management activities would also occur through the existing Mid-Columbia coordinating committees.

S.5.3 ALTERNATIVE 3 (PROPOSED ACTION – PROJECT HCPs)

The proposed action consists of implementing the three HCPs for the operation of the Wells, Rocky Reach, and Rock Island hydroelectric projects. The HCPs were developed to conserve and protect listed and non-listed anadromous fish species over the long term, and to support ongoing compliance with the Endangered Species Act, while allowing continued operation of the three projects. The HCP fish protection measures and methodologies proposed to implement these measures would represent comprehensive longterm settlement agreements under the Endangered Species Act, the Federal Power Act, the Fish and Wildlife Conservation Act, the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act, the Northwest Power Planning and Coordination Act, and Title 77 RCW. Because the Agreements are comprehensive settlements, they propose a standard and scope greater than that required under the Endangered Species Act. The objective of the HCPs is to achieve percent no net impact for anadromous salmonids affected by the projects. This objective applies not only to the listed spring-run chinook salmon and steelhead, but also to the other anadromous salmonids in the Mid-Columbia River.

Protection for the migrating species is accomplished through a series of performance (survival) standards, which are based upon actual survival of the migrating species, not simply measures to be implemented regardless of their actual benefit to the migrating species. Unavoidable mortality is mitigated though tributary habitat improvements and state of the art hatchery supplementation.

The primary purpose of the HCP agreements is to obtain an incidental take permit from NMFS to comply with the Endangered Species Act for any take of listed anadromous fish as a result of project operations and satisfy the FERC relicensing requirement for the Plan species.

Issuance of an incidental take permit is a Federal action subject to NEPA compliance. The purpose of NEPA is to promote analysis and disclosure of the environmental issues surrounding a proposed Federal action and to reach a decision that reflects NEPA's mandate to strive for harmony between human activity and the natural world. As a cooperating agency, FERC also intends to utilize this EIS for subsequent licensing decisions (which are considered separate Federal actions), and the State agencies intend to use the information to satisfy state environmental requirements (SEPA).

The requirements of Section 10 of the Endangered Species Act provide the guidelines for HCP preparation. The information within each of the HCPs includes the following:

- the environmental setting in the project vicinity,
- structural and operational features of the project,
- existing operations related to anadromous salmonids,
- existing mitigation and monitoring measures and their effectiveness,
- unresolved issues related to anadromous salmonids (note: The 1998 Incidental Take Permit Applications indicated that there were unresolved issues at the time the applications were submitted. Unresolved issues were resolved by the amended applications filed in 2002. The HCPs address changing circumstances and unknown future events through committee processes and adaptive management (see Section 10.4.2 of the Wells HCP and Section 10.3.2 of the Rocky Reach and Rock Island HCPs).

- proposed mitigation and enhancement measures to address unresolved and unknown future issues,
- proposed monitoring,
- costs and funding, and
- alternatives to the proposed measures.

In addition to Section 10 requirements, the issuance of an incidental take permit and amending a FERC license are Federal actions subject to Section 7 of the Endangered Species Act. Although Section 7 and Section 10 are similar, Section 7 introduces several considerations into the HCP process that are not explicitly required by Section 10. These considerations include the assessment of indirect effects, effects on Federally listed plants, and effects on critical habitat. As a result, NMFS and FERC are required to initially consult with the Services (NMFS and USFWS) to ensure that their actions proposed in the HCP are "not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification" of critical habitat.

S.5.3.1 HCP Species

The Plan species addressed in the HCPs are spring-run chinook salmon, summer/fall-run chinook salmon, sockeye salmon, coho salmon, and steelhead inhabiting the Upper Columbia River (Table S-2) (see Section 13.19 of the Wells HCP and Section 13.20 of the Rocky Reach and Rock Island HCPs). In addition, the HCPs also identify Permit species (species covered under the incidental take permit application). The Permit species include all the Plan species except coho salmon. The native coho salmon populations have been extirpated from the Upper Columbia River, are not subject to Endangered Species Act protection, and therefore do not require the issuance of an incidental take permit.

TABLE S-2. PLAN AND PERMIT SPECIES STATUS, RELATIVE TO THE HCPs (ALTERNATIVE 3)

Species	ENDANGERED SPECIES ACT STATUS	EVOLUTIONARILY SIGNIFICANT UNIT	HCP STATUS
Steelhead	Endangered (August 1997)	Upper Columbia River	Plan and Permit Species
Spring-Run Chinook Salmon	Endangered (March 1999)	Upper Columbia River	Plan and Permit Species
Summer/Fall-Run Chinook Salmon	Not Warranted (March 1998)	Upper Columbia River	Plan and Permit Species
Sockeye Salmon	Not Warranted (March 1998)	Okanogan River	Plan and Permit Species
		Lake Wenatchee	
Coho Salmon	Extirpated	Upper Columbia River	Plan Species

S.5.3.2 HCP Term

The terms of the three HCPs and any incidental take permits are to be 50 years from the date the HCPs are executed (in the case of Chelan County PUD), and approved by FERC (in the case of Douglas County PUD) (see Section 1.1 in the Wells, Rocky Reach and Rock Island HCPs). In the event any PUD project is not relicensed to that PUD, the corresponding HCP for that project would terminate. A 50-year term was selected because it corresponds to the maximum length of a FERC license, although the HCP process will not necessarily coincide with the FERC relicensing process at the three projects. A lengthy term is also appropriate because of the length of time and expense involved in negotiating and consulting on each of the HCPs. For example, the negotiation process for the three HCPs considered in this EIS began in 1993.

Although some HCP measures are currently being implemented by the PUDs, the HCPs would not be fully implemented until the agreements are executed by the signatory parties and the regulatory review processes have been completed. As a result, the effective date of the agreements would be the later of when (1) FERC issues a final order approving and incorporating the agreements in the project licenses, (2) NMFS issues an incidental take permit, and (3) the USFWS completes the necessary consultation

under the Endangered Species Act. Based on the current schedule, the terms of the HCPs should extend from approximately 2003 through 2053. Payments to the Plan species Account would be initiated 90 days after the effective date of each HCPs and adjusted for inflation from 1998.

The HCPs also have termination provisions if the performance standards are not achieved (see Section 1 of the Wells, Rocky Reach, and Rock Island HCPs). An HCP could be less than 50 years under the following circumstances:

- FERC issues a non-power license for the project,
- FERC orders removal or drawdown of the project, or
- if the no net impact standard has not been achieved or maintained by 2013 (2018 for the Wells Project), or if no net impact has been achieved and maintained but Plan species are not rebuilding and the project is a significant factor in the failure to rebuild,
- if a party fails to comply with the terms of the HCP,
- if the obligations imposed by the HCP are impossible to achieve,

- if NMFS revokes the incidental take permit, or
- if a regulatory entity takes action that materially alters or is contrary to one or more provisions of the HCP.

Any party to the HCP may elect to withdraw from the agreement at any time, based on the non-compliance provisions of the HCP agreements. However, NMFS and USFWS will not exercise their right to withdraw from the HCP until at least 2013 (2018 for the Wells Project) if the PUDs have complied with all aspects of the agreement but have not met the survival standards. If mutual agreement is reached between the PUDs and the two Federal agencies, the Services (NMFS and USFWS) can seek reservoir drawdown, dam removal, and/or non-power operations without withdrawing from the agreement or suspending or revoking the incidental take permit.

During the 50-year HCP term, all three projects would undergo a relicensing process with FERC. It is the intention of the HCPs that mitigation measures agreed to as part of the HCPs be consistent with, and form the basis of, subsequent FERC license articles developed to address impacts on anadromous salmonids. Therefore, unless the parties to the HCPs withdraw from the HCP agreements (following the prescribed withdrawal procedures), they would be supportive of a new license, under which the HCPs would constitute the terms, conditions, and recommendations for Plan species under Section 10(a), Section 10(j), and Section 18 Fishway Prescriptions in the new license (see Section 9.5 of the Wells HCP and Section 9.2 of the Rocky Reach and Rock Island HCPs).

The PUDs have voluntarily implemented some provisions of the HCPs because specific deadlines for reaching the survival standards were established in the HCPs. During this period, the PUDs have had the ultimate authority on pursuit and implementation of specific bypass measures since 1998. However, the existing FERC license

articles, settlement agreements, and stipulations remain in effect to address dispute resolution proceedings, spill volumes, and hatchery compensation levels. Components of the HCPs that address each of these issues would not be implemented until the agreements have been ratified. To address ongoing Endangered Species Act issues, FERC issued an order approving the Rocky Reach Bypass System and NMFS issued a Biological Opinion for the Wells Project (which has since expired).

S.5.3.3 HCP Mitigation Objectives

All measures proposed in the HCPs are intended to minimize and mitigate impacts to the Plan species, to the "maximum extent practicable" as required by the Endangered Species Act. The HCPs also address the obligations of the PUDs under the Federal Power Act, the Fish and Wildlife Conservation Act, the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act, the Northwest Power Planning and Coordination Act, and Title 77 RCW (see Section 9.7 of the Wells HCP and Section 9.4 of the Rocky Reach and Rock Island HCPs).

The HCPs would mitigate impacts from dam operations in areas directly affected by those operations (project areas). The project areas extend from approximately 1,000 feet downstream of each dam (tailrace) to 1,000 feet downstream of the next dam upstream (reservoir). The PUDs would also provide funding for hatchery supplementation and tributary habitat improvement programs to offset losses not directly mitigated at the project.

S.5.3.4 HCP Performance Standards

The HCPs have specific performance standards that relate to the survival of each Plan species (see Section 4 of the Wells HCP and Section 5 of the Rocky Reach and Rock Island HCPs). The overall performance standard is to achieve no net

impact to the Plan species through each dam. This term takes into account the fact that 100 percent equivalent survival cannot be achieved at the projects alone, requiring additional mitigation through off-site measures to increase salmonid productivity (e.g., hatchery supplementation programs and tributary habitat improvements).

The no net impact standard consists of two components:

- 1. A 91 percent combined adult and juvenile project survival rate achieved within the geographic area of the projects by fish passage improvement measures.
- 2. Compensation for the 9 percent unavoidable project mortality provided through hatchery and tributary programs, with compensation for 7 percent mortality provided through hatchery programs and compensation for the remaining 2 percent mortality provided through tributary habitat improvement programs.

It is the intention that these no net impact components will contribute to the rebuilding of tributary habitat production capacity and the basic productivity and numerical abundance of the Plan species. Tributary habitat improvement programs would involve the protection and restoration of salmonid habitat within the Columbia River watershed (from the Chief Joseph tailrace to the Rock Island tailrace), and the Okanogan, Methow, Entiat, and Wenatchee River Basins. The hatchery programs would be consistent with the objective of rebuilding naturally reproducing populations in their native habitats, while maintaining genetic and ecological integrity and supporting harvest.

Monitoring of both on-site and hatchery mitigation measures would be conducted, and mitigation measures would be modified, as necessary, to achieve or maintain the no net impact standard. A comprehensive evaluation of the hatchery mitigation program will be

conducted to assess the effectiveness for achieving the no net impact standard in 2013, and every 10 years thereafter. Based on the results of these evaluations, adjustments could be made to the program. However, compensation for no more than 7 percent unavoidable project mortality would be provided through hatchery compensation without agreement of the parties that signed the HCPs.

Compensation for up to 2 percent unavoidable project mortality would be through tributary habitat improvements. This compensation level is assumed, and will not be monitored for actual survival contribution during the 50-year term of the HCPs due to the difficulty and uncertainties associated with monitoring and quantifying the effects of tributary habitat improvements. However, a tributary assessment program will be funded to monitor and evaluate the relative performance of tributary improvement projects. The intent of this assessment program is to ensure the most cost effective and efficient use of the tributary improvement funds, but not to quantify the actual survival benefits.

The performance standards for the HCPs are the result of an extensive collaborative process dating back to 1993, and represent the collective wisdom and professional judgment of the scientists and regional policy makers participating in the process. In addition, the standards are generally consistent with the performance standards included in the 2000 Federal Columbia River Power System biological opinion for the Lower Snake and Columbia River projects (NMFS 2000c). In-river survival evaluations will be used to determine whether the survival standards are being achieved.

The no net impact and survival standards are designed to have several layers of requirements to provide the most flexibility in achieving and measuring the goal of recovering and stabilizing the anadromous fish runs in the Mid-Columbia River. In particular, although the 91 percent survival standard combines the adult and juvenile

fish survival through the project, it is recognized that it is not currently possible to conclusively differentiate hydro-related mortality from natural adult fish losses. Therefore, the combined adult and juvenile survival standard will initially be measured through alternative survival measurements relative to juvenile fish passage. These alternative survival measurements assume a 2 percent adult mortality rate, based on the best available data throughout the region, which suggests a 98 to 100 percent survival rate of adults passing each hydroelectric project.

The alternative juvenile survival measurement was established to provide additional flexibility in estimating project impacts on each Plan species, given the species-related limitations of the available assessment techniques. The alternative metrics are for either juvenile project or juvenile dam passage survival. The alternative juvenile project passage survival metric is 93 percent (which is the survival rate over 95 percent of each Plan species migration through a project's reservoir, forebay, dam, and tailrace). This 93 percent survival goal includes direct, indirect, and delayed mortality, as it relates to the project, wherever it occurs and can be measured.

If juvenile project passage survival cannot be accurately measured, juvenile dam passage survival can be used as the next best alternative to determine if the HCP survival standards are met for each Plan species. The juvenile dam passage survival standard is set at 95 percent, and encompasses the survival of 95 percent of the juveniles passing through a project's forebay, dam, and tailrace areas. However, unlike the project survival standard, dam passage survival estimates do not include indirect or delayed mortality as they relate to project operations. Therefore, even if this standard is met, additional evaluations will be needed (as measurement technologies allow) to verify achieving the no net impact standard of the HCPs.

If neither of these alternative juvenile survival rates can be directly measured with the available technology, juvenile dam passage survival would be calculated based on the best available data (including the proportion of fish utilizing specific passage routes and estimated survival rates for each route). This calculation would consider the same elements as the directly measured juvenile dam passage survival technique, although off-site data may be used when project-specific data are not available. This calculation process could be used for Plan species such as sockeye and subyearling chinook because directly measuring dam passage survival for these species is currently not possible with existing technology.

The initial hatchery production levels are based on average adult returns and adult to smolt survival rated during a baseline period, and the need to compensate for up to 7 percent unavoidable project-related mortality. In response to requests from the Tribes, NMFS has agreed to fully permit the initial production levels identified in the HCPs through 2013. During 2013, and every 10 years afterward, the hatchery production levels would be evaluated and adjusted to achieve and maintain no net impact to each Plan species. These assessments would allow adjustments in production based on average adult returns and any changes in adult-to-smolt survival rate or smolt-to-adult survival rates for the hatchery production facilities. However, hatchery production levels established as compensation for original project inundation impacts are not subject to change.

In addition to hatchery program modifications based on the results of survival studies, there are procedures established to allow program reductions if the 7 percent hatchery compensation level is determined by NMFS to be inappropriate for species recovery. Such Endangered Species Act policy adjustments could occur in 2013 and every 10 years afterward, at the time of program reviews. Such policy changes might be required if the interactions of hatchery and wild fish are proven to be delaying the recovery process. These interactions include direct impacts such as

competition for space and food, disease transmission, and predation.

Additional evaluations are expected over the next 10 years to determine the amount of hatchery supplementation that can be allowed without negatively impacting the listed species.

As part of the effort to achieve the performance standards, the PUDs would use their best efforts to evaluate, improve, maintain, and operate adult passage fishways to meet criteria established by the coordinating committees. The criteria currently used for the adult fishways were developed in cooperation with the existing Wells Coordinating Committee, Rock Island Coordinating Committee, and the Mid-Columbia Coordinating Committee. The adult fishway operating criteria for the Wells Dam can be found in the Adult Fish Passage Plan (Appendix A) of the Wells HCP. For Rocky Reach and Rock Island, the adult fishway operating criteria is referred to as the Detailed Fishway Operating Plan (DFOP) (see Appendix A of the Rocky Reach and Rock Island HCPs).

Measures implemented at the projects to meet the performance criteria are referred to as "tools", which include any action, structure, facility, or program (on-site only) intended to improve the survival of Plan species migrating through the project areas.

Although there is limited survival information available for all the Plan species at each of the three dams, recent improvements in fish tagging technology (e.g., PIT-tags, miniature radio, acoustic and balloon tags) will provide more detailed and accurate future assessments.

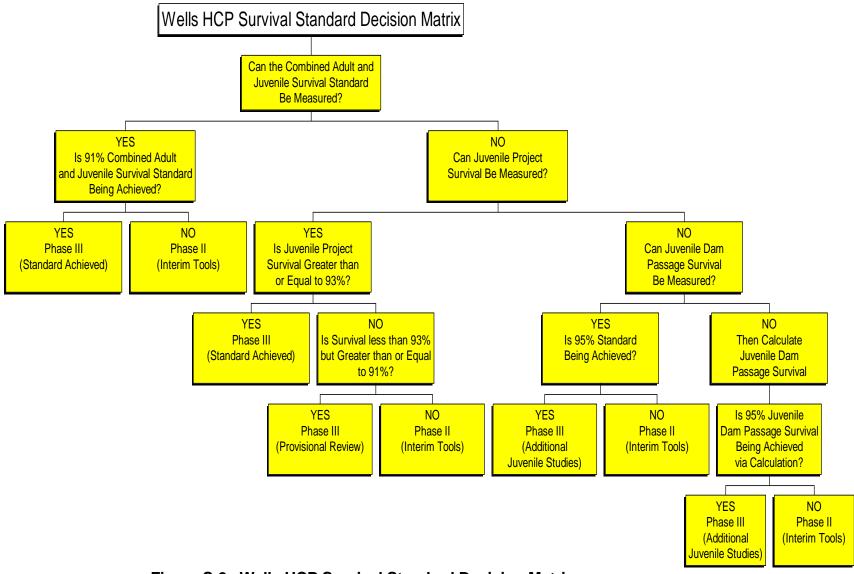
The HCPs set an initial period for the PUDs to achieve the juvenile project or juvenile dam passage survival goals followed by up to 3 years of evaluation (see Section 4.2 of the Wells HCP and Section 5.3 of the Rocky Reach and Rock Island HCPs). The 3-year evaluation period has been completed by Douglas County PUD for yearling chinook and steelhead, while the first

year of evaluation at Rocky Reach and Rock Island dams is scheduled to begin in 2004 and 2002, respectively. If the survival levels are not met, the HCP coordinating committees (which include NMFS participation) would then identify additional tools to implement, prior to the next migration period, to achieve the combined adult and juvenile, juvenile project or juvenile dam passage survival goals. Detailed discussions of the evaluation phases are provided below in Section 3.2.2.6, HCP Phases.

S.5.3.5 HCP Phases

The HCP survival standards would be evaluated in three phases (see Section 4.2 of the Wells HCP and Section 5.3 of the Rocky Reach and Rock Island HCPs). During Phase I, the PUDs would evaluate survival rates for those Plan species that can be studied with existing methodologies. Juvenile fish survival studies would be measured at a 95 percent confidence level, with a standard error of no more than plus or minus 2.5 percent. However, if all testing protocols and model assumptions are adhered to, the coordinating committees can (by unanimous approval) accept study results with a standard error of plus or minus 3.5 percent.

Survival studies would be conducted over a 3year period to determine the survival rates. Study results that meet the precision and testing protocol requirements would be included in the 3-year average. Depending on the results of the 3-year survival studies, the PUDs would proceed to either Phase II or Phase III). The decisionmaking process for interpreting the survival study results is summarized in a decision matrix of the phase determination process (Figures S-2 and S-3). The juvenile survival studies conducted during Phase I could indicate that the standards were achieved for some species and not others. This would result in different phase designations for the various Plan species. The coordinating committees can also designate a representative or surrogate species for testing if the target species cannot be accurately tested with the existing technology.



. Figure S-2. Wells HCP Survival Standard Decision Matrix

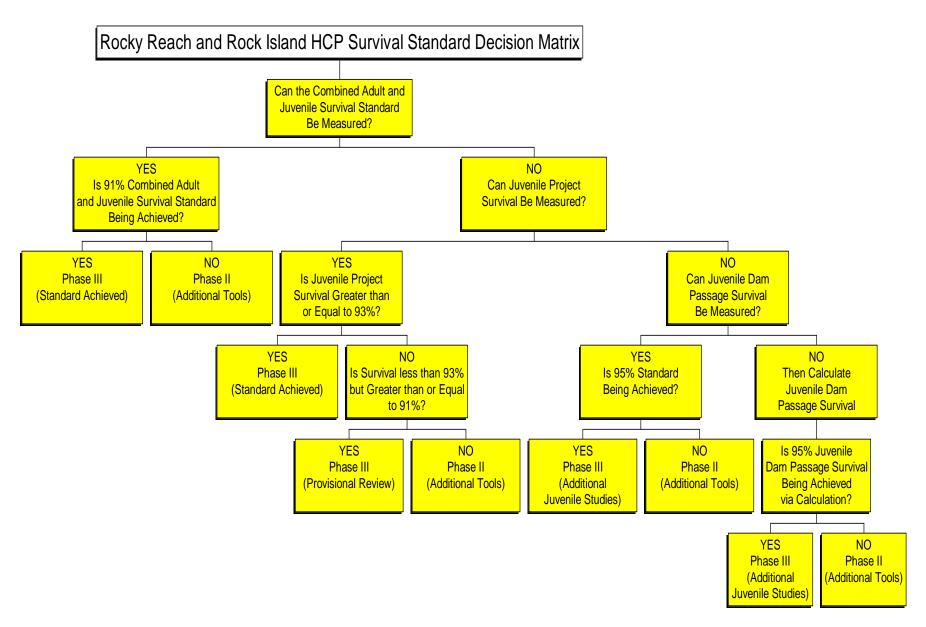


Figure S-3. Rocky Reach and Rock Island HCP Survival Standard Decision Matrix

If the Phase I evaluations conclude that the applicable survival standard has not been achieved, the PUD would enter Phase II (Interim Tools/ Additional Tools). In this phase, the coordinating committee would jointly decide on either interim tools or additional tools for the PUD to implement to achieve the pertinent survival standard. Once implemented, up to 3 years of evaluations would be conducted to verify compliance with the standard and appropriateness of moving into Phase III. Until the survival standard(s) being measured are achieved, the PUDs will continue to implement either interim tools or additional tools to meet the standard(s). However, if it is determined that the standards cannot be met, the parties can withdraw from the HCP agreements. There are several determination levels under Phase III to address uncertainties or gaps in the available information. The coordinating committees would determine if the Phase III level has been achieved, at each project and for each Plan species, as follows:

- Standard Achieved Verified compliance with the 91 percent combined adult and juvenile survival standard or 93 percent juvenile project survival.
- Provisional Review Measured juvenile project survival less than 93 percent but greater than or equal to 91 percent.
- Additional Juvenile Studies Measured or calculated 95 percent juvenile dam passage survival.

Under Phase III (Standard Achieved), the PUDs would reevaluate survival every 10 years. These 1-year reevaluation processes would include one representative species for the spring migration period and another for the summer migration. The resulting survival estimates would be included in the cumulative average for those species. If the standard is no longer being achieved, additional evaluations would occur. If survival levels remain below the standards after 3 years of reevaluation, the PUD would move into

Phase II (Additional Tools) for that species, and follow the procedures discussed previously for Phase II. In addition, the coordinating committee would consider reevaluating other Phase III (Standards Achieved) species.

If the reevaluation studies show that the standards are being exceeded, the coordinating committees could make adjustments to the passage measures or the unavoidable mortality mitigation levels to maintain the no net impact standard. At Rock Island or Rocky Reach dams, the spill requirements could be adjusted for the following migration season used by that species, such that the survival standard is achieved but not exceeded. However, the survival standard could be exceeded for a particular species, if measures implemented primarily for another species provide additional survival benefits to both species. At Wells Dam, the coordinating committee could adjust the hatchery supplementation rates from the 7 percent level based on actual project survival, such that the no net impact standard is achieved but not exceeded.

A Phase III (Provisional Review) determination allows the PUD a one-time (Plan species specific) 5-year period to implement additional measures or conduct additional survival studies to achieve or verify the achievement of the pertinent survival standard. If the survival goal is subsequently met, the PUD would follow Phase III (Standard Achieved) or Phase III (Additional Juvenile Studies) procedures. If the pertinent standard cannot be achieved, Phase II (Interim Tools) procedures would be followed for Wells and Phase II (Additional Tools) would be followed for Rocky Reach and Rock Island. However, even if the juvenile dam passage survival rate (calculated or measured) is determined to be 95 percent or greater, Phase III (Additional Juvenile Studies) procedures would apply.

The Phase III (Additional Juvenile Studies) classification is provided because juvenile dam passage survival estimates do not address juvenile mortality in the reservoir. Therefore, even if the

95 percent juvenile dam passage survival (measured or calculated) is met or exceeded, either the 91 percent combined adult and juvenile project survival estimate or the 93 percent juvenile project survival metric would still be measured when appropriate monitoring methods are available.

Based on the survival and the fish passage efficiency studies, the parties to the HCP recognize that the Douglas County PUD has achieved the 93 percent juvenile project survival goal for yearling chinook and steelhead. In addition, the 95 percent juvenile dam passage survival goal is assumed to have been met for sockeye and subyearling chinook, until adequate evaluation methodologies are available to verify survival of these species.

For the Chelan County PUD, the evaluation period (Phase I) began at Rock Island in 2002 and would occur between 2004 and 2006 for Rocky Reach. The coordinating committees would use these evaluation results to make a phase determination for each Plan species.

Whenever Phase I evaluations indicate that the survival standards are not being achieved for a specific species, Phase II (Interim Tools) would be applied for the Wells Project and Phase II (Additional Tools) would be applied to the Rocky Reach and Rock Island projects. Phase II (Interim Tools) for Wells includes a set of project specific actions, that could be implemented at the project, to increase survival above the pertinent survival standard. Following the implementation of Interim Tools, an evaluation of the survival benefit of these actions will take place. For the Rocky Reach and Rock Island projects, the coordinating committees would identify the additional tools or studies that are to be implemented during Phase II. The coordinating committees shall use the following criteria when deciding which interim/additional tools to be implemented during Phase II. These criteria are:

1. likelihood of biological success;

- 2. time required to implement; and
- 3. cost-effectiveness of solutions, but only where two or more alternatives are comparable in their biological effectiveness.

The PUD would continue to implement Phase II tools for each Plan species that is not meeting the pertinent survival standard. The coordinating committee would determine the number of valid studies (not to exceed 3 years) necessary to verify the survival rate and make a phase determination, following the implementation of the interim/additional tools.

S.5.3.6 Dispute Resolution

The HCP agreements stipulate a dispute resolution procedure that would apply to all disputes over the implementation and compliance of the agreements (see Section 11 of the Wells, Rocky Reach, and Rock Island HCPs). These procedures rely on unanimous agreement of the pertinent coordinating committee representatives present for the dispute resolution process.

If a unanimous decision cannot be reached within a hatchery or tributary coordinating committees, then the dispute would be decided by the pertinent HCP coordinating committee. If the HCP coordinating committee cannot resolve a dispute elevated from the hatchery or tributary committee (or the HCP coordinating committee cannot resolve a dispute amongst themselves) then the dispute would be decided by a policy committee, comprised of executives of all signatory parties. If a unanimous decision of the attending representatives of the policy committee cannot be reached, each of the HCP parties may pursue any other right they might otherwise have to achieve their objectives. However, the agreement encourages the parties to seek a resolution through an alternative resolution process, including mediation or arbitration.

S.5.3.7 HCP Committees

The three HCPs would be implemented through a group of committees established for each project (see Section 6 of the Wells HCP and Section 4 of the Rocky Reach and Rock Island HCPs). Each project would have a coordinating committee, a tributary committee, and a hatchery committee.

The coordinating committees would oversee HCP monitoring programs, including the selection of the most appropriate survival standard to measure, protocols and methodologies to assess survival, and review of the study results to determine whether or not the survival standards have been achieved. The coordinating committee would also provide input on the choice of measures implemented under Phase I, and periodically evaluate and adjust the protection measures (after Phase I) to assess actual project survival and unavoidable project mortality.

Although adjustments can be made to ensure the no net impact standard, no more than 9 percent unavoidable project mortality shall be made up through hatchery and tributary compensation. If any project, for any species, cannot achieve the 91 percent combined adult and juvenile project survival, or 93 percent juvenile project survival, or 95 percent juvenile dam passage survival standard, then the PUDs shall consult with the signatory parties through the coordinating committees to jointly seek a solution. The committee would have the ability to select an independent third party to provide scientific review of any disputed survival study results.

The tributary committees are charged with the task of selecting projects and approving project budgets from the Plan Species Account for purposes of implementing the Tributary Conservation Plan.

The hatchery committees are responsible for evaluating the hatchery programs and ensuring that adequate compensation is being maintained based on the 7 percent compensation goal.

The tributary and hatchery committees would be formed after the HCP is approved by FERC, and would operate simultaneously and independently throughout the HCP terms.

S.5.3.8 HCP Conservation Plan and Compensation Measures

The measures described below are currently considered to be the tools that Chelan and Douglas County PUDs would use to meet 91 percent combined adult and juvenile project survival, or 93 percent juvenile project survival, or 95 percent juvenile dam passage survival.

Wells Dam

Outside of the existing mitigation measures negotiated during the 1990 long-term fisheries settlement agreement for the Wells Project (FERC 1991), no new structural modifications have been identified to date. The combination of the existing juvenile fish bypass system at Wells Dam and the replacement of the turbine units with minimum gap type turbines has produced a three year average project survival of 96.2 percent for yearling chinook and steelhead.

As a result, the HCP signatory parties have determined that Douglas County PUD has achieved the Phase III (Standard Achieved) designation for yearling chinook and steelhead. The HCP parties also believe that the calculated estimate of juvenile dam passage survival for sockeye and subyearling chinook is probably greater than the 95 percent standard and that Douglas County PUD has most likely achieved Phase III (Additional Juvenile Studies) for subyearling chinook and sockeye.

Based on the measured or calculated survival information, the juvenile bypass system would continue to be operated in a manner consistent with that used during the evaluation phase (see Section 4.3 of the Wells HCP). Specific

measures to be implemented include the following:

- Continuously operate the bypass between April 10 and August 15, or longer if necessary to encompass 95 percent of a juvenile migration period.
- Coordinate with the HCP signatory parties and other resource agencies to address total dissolved gas and other water quality issues.
- Maintain effective predator control measures consisting of northern pikeminnow removal and piscivorous bird harassment and control measures.
- Operate and maintain the adult fish passage systems according to procedures outlined and criteria developed through the coordinating committee, and use best efforts to eliminate identified sources of adult injury and mortality while passing the project.
- Evaluate the biological significance of adult fallback rates and steelhead kelt loss at the project, and implement recommendations of the coordinating committee likely to significantly improve survival.

Rocky Reach Dam

The Chelan County PUD would be undertaking various interim, prototype, and permanent measures at the Rocky Reach Project in an effort to achieve the 91 percent combined adult and juvenile project survival, or 93 percent juvenile project survival, or 95 percent juvenile dam passage survival standards. These measures would include interim spill, bypass diversion screen operations, surface collection bypass system construction and evaluation, turbine replacement, and predator control (see Section 5.4 of the Rocky Reach HCP). The appropriate mix of measures would vary as the surface collection system is improved and its efficiency tested and quantified.

Phase I testing at Rocky Reach Dam is expected to begin in 2004 for yearling chinook and steelhead. The surface collection juvenile bypass system is scheduled to be completed by 2003. Chelan County PUD will use the 2003 juvenile outmigration season to conduct studies to identify specific physical or operational modifications prior to the first year of survival testing (2004). Based on the results of these initial studies, spill levels will be adjusted for the Phase I testing period (2004 – 2006). Survival rates for subyearling chinook and sockeye would be measured if technology exists, or calculated based on estimated survival rates for, and the proportion of these species passing, each passage route at the project.

Survival data would determine the number, type, and magnitude of the various protective measures needed to achieve the 91 percent combined adult and juvenile project survival, or 93 percent juvenile project passage survival, or 95 percent juvenile dam passage survival standards. Actions would also be taken to improve survival and ensure timely passage of adult anadromous salmonids through the project. The following measures would be implemented:

- Install a juvenile fish bypass system consisting of a surface collection system with secondary collection from a limited number of turbine intake screens.
- Continuously operate the bypass between April 1 and August 31, or longer if necessary to encompass 95 percent of a juvenile migration period.
- Modify replacement turbine runners to improve survival of juvenile anadromous salmonids as much as possible, given manufacturing, technical, and installation schedule limitations.
- Continue implementing a spill program that provides spill levels to achieve 95 percent survival when used with the surface collector

during a period encompassing 95 percent of migration periods of spring- and summer-migrating Plan species. In addition, provide 25 percent spill during the Okanogan sockeye outmigration period (for up to a maximum of 21 days). Spring spill would begin no later than April 20 and generally end no later than June 15. The summer spill period is between July 1 and August 15.

- Coordinate with the HCP parties and other resource agencies to address total dissolved gas and other water quality issues
- Maintain effective predator control measures consisting of northern pikeminnow removal and piscivorous bird harassment and control measures.
- Operate and maintain the adult fish passage systems according to criteria developed through the coordinating committee, and use best efforts to eliminate identified sources of adult injury and mortality while passing the project.
- Evaluate the biological significance of adult fallback rates and steelhead kelt loss at the project, and implement recommendations of the coordinating committee likely to significantly improve survival.
- Perform the necessary studies to properly monitor and evaluate on-site mitigation measures.

Rock Island Dam

Similar to the Rocky Reach Project, the Chelan County PUD would undertake various interim, prototype, and permanent measures at Rock Island Dam in an effort to achieve the 91 percent combined adult and juvenile project passage survival, 93 percent juvenile project passage survival, or 95 percent dam passage survival standards for juvenile anadromous salmonids.

The HCP identifies several specific measures to implement at Rock Island Dam to improve fish passage survival (see Section 5.4 of the Rock Island HCP). One measure is to replace the existing Fisheries Conservation Account spill program with a program that provides spill levels of 20 percent of the daily average flow during a period encompassing 95 percent of the migration period for each Plan species. Under this new program, spring spill would begin no later than April 17 and generally end no later than June 15. The summer spill period is between July 1 and August 15. However, spill periods can be extended to encompass 95 percent of the migration period for each Plan species. The fish migration periods will be determined by fish captured in the second powerhouse juvenile fish bypass system.

Another measure outlined in the HCP is to maintain effective predator control measures consisting of northern pikeminnow removal and piscivorous bird harassment and control measures.

The PUD would also operate and maintain the adult fish passage systems according to criteria developed through the coordinating committee, and use best efforts to eliminate identified sources of adult injury and mortality while passing the project. The HCP also stipulates the evaluations of the biological significance of adult fallback rates and steelhead kelt loss at the project, and implementation of the coordinating committee recommendations likely to significantly improve survival.

Survival data obtained at each step in the process would determine the number, type, and magnitude of the various protective measures needed to achieve the pertinent survival standard. Actions would also be taken to improve survival and ensure timely passage of adult anadromous salmonids through the project to meet the 91 percent combined adult and juvenile project survival standard. Some or all of the following measures would be implemented:

- designing, modeling, prototype testing, and installing spill gate modifications to provide surface spill to increase fish passage efficiency;
- testing and evaluating various spill configurations;
- designing, modeling, prototype testing, and installing a turbine bypass system consisting of a surface bypass collection system, with or without secondary collection from turbine intakes;
- replacement of turbine runners to improve survival of juvenile anadromous salmonids that pass through the units, and limiting use of the Powerhouse 1 turbines;
- testing a forebay guidance curtain to route juvenile anadromous salmonids into surface bypass collectors;
- maintaining effective predator control measures; and
- performing necessary studies to properly monitor and evaluate on-site mitigation measures.

Tributary Conservation Plan

Alternative 3 would create a Plan Species Account, to be used to fund activities for the protection and restoration of Plan species habitat within the Columbia River watershed (from Chief Joseph tailrace to the Rock Island tailrace), and the Okanogan, Methow, Entiat, and Wenatchee River watersheds, to compensate for the unavoidable 2 percent project mortality (see Section 7 of the Wells, Rocky Reach and Rock Island HCPs).

Restoration projects would occur within one of seven categories: (1) habitat protection, (2) floodplain rehabilitation, (3) channel function, (4) instream flow improvements, (5) fish passage

improvements, (6) riparian restoration, and (7) water quality improvements. These habitat improvement projects could include, but are not limited to:

- providing access to currently blocked stream sections or oxbows,
- removing dams or other passage barriers on tributary streams,
- improving or increasing the hiding and resting cover habitat that is essential for these species during their relatively long adult holding period,
- improving in-stream flow conditions by correcting problematic water diversion or withdrawal structures, and
- purchasing important aquatic habitat shoreline areas for preservation or restoration.

Such tributary habitat conservation and restoration measures are expected to improve the migration and rearing conditions for all anadromous fish species, as well as other resident fish. These measures are also expected to help decrease bank erosion, sedimentation, channel scouring, and water quality problems. The improved conditions would increase the opportunities for successful spawning by facilitating the return of adult anadromous salmonids to their natal spawning areas at the proper time and in good health. The tributary committees would review all habitat restoration projects according to the criteria set forth in the HCP supporting documents provided as appendices to the HCPs.

The funding levels for each project to the Plan Species Account are set in the HCPs. The combined total contributions through the 50-year term of the HCPs will be over \$46.5 million in 1998 dollars. For the Wells Project, the Douglas County PUD would fund an initial contribution to the account of \$1,982,000 (1998 dollars adjusted

for inflation). Five years after the initial contribution, the PUD could either provide annual payments of \$176,178 (1998 dollars) throughout the HCP term or provide an up-front payment of \$1,761,781 (equivalent to 10 yearly payments in 1998 dollars), deducting the actual costs of bond issuance and interest. After a total of 15 years, the HCP parties would determine the contribution method of the remaining funds (at a rate equivalent to \$176,178 per year).

These funding levels are based on a 2 percent mitigation level for adult mortality. However, if the adult passage survival is determined to be greater than 98 percent and the juvenile project passage survival is greater than 93 percent, for any one of the Permit species, contributions to the Tributary Fund would be reduced to reflect the actual adult survival estimate of that species.

The adult survival estimates for each Permit species would independently determine one quarter of the funding to the Plan Species Account for each project. For example, if adult steelhead and spring-run chinook salmon survival were determined to be 99 percent, the annual contributions to the Plan Species Account would be based on 1 percent mortality for these two species. However, the annual contributions for the other two Permit species would continue to be based on a 2 percent mitigation level. Under this scenario, the annual contributions to the account would be reduced from a full 8/8th contribution (2 percent for four species) to a 6/8th contribution.

For the Rocky Reach Project, Chelan County PUD would fund the Plan Species Account at \$229,800 annually (1998 dollars adjusted annually for inflation) for the term of the HCP. At the request of the tributary committee, advanced contributions would be made during the first 15 years of the agreement.

For the Rock Island Project, the Chelan County PUD would provide \$485,200 annually (1998 dollars adjusted annually for inflation) to the Plan Species Account. At the request of the tributary committee, advanced contributions would be made during the first 15 years of the agreement.

The Plan Species Account would be vested with the authority to expend money contributed by the PUDs for activities within the Columbia River watershed (from Chief Joseph Dam tailrace to the Rock Island tailrace), and including the Okanogan, Methow, Entiat, and Wenatchee River watersheds to increase productivity of anadromous salmonids in the Mid-Columbia River area.

The tributary committee would be composed of one representative of each of the signatory parties. The committee may select other expert entities, such as land and water trust/conservancy groups, to serve as additional, non-voting members of the tributary committee. The committee would be charged with the task of selecting projects and approving project budgets for the purposes of implementing the Tributary Conservation Plan.

The tributary habitat improvement projects would be determined on a case-by-case basis by the tributary committee, subject to the guidelines and standards of biological and economic efficiency and the financial resources of the Plan Species Account. The guidelines for tributary projects place the highest priority on maintaining and improving stream channel diversity and floodplain function. The projects would seek to conserve and protect riparian habitat to improve incubation and rearing conditions in tributary streams.

Through the Tributary Assessment Program, the PUDs would provide support for assessing the relative merits of each tributary project funded (see Section 7.5 of the Wells, Rocky Reach, and Rock Island HCPs). Funding for the assessment program is separate from the Plan Species Account, but is set for approximately \$200,000 per project (up to \$600,000 for all three projects) (not subject to inflation adjustment) during the term of the HCPs.

Hatchery Compensation Plan

Each hatchery committee would consist of one representative of each HCP signatory party. These committees would direct the effort required of each PUD to meet the 7 percent hatchery compensation goal to achieve no net impact for each Plan species. The initial estimated HCP hatchery production capacities for each Plan species was based on the average adult returns of that species for a baseline period, the 7 percent compensation level, and baseline adult/smolt survival rates for existing Mid-Columbia River hatcheries (see Section 8 of the Wells, Rocky Reach, and Rock Island HCPs).

The estimated production capacity shall be adjusted periodically, excepting for original inundation mitigation, to achieve and maintain no net impact to the Plan species. Adjustments to the hatchery compensation level may include reduction of production to conform to actual project mortality, as determined from monitoring and evaluation, or increases in production as the base population level increases in the recovering anadromous fish populations. Hatchery compensation may be increased either by increasing the number of fish produced or by increasing the survival of fish produced at the initial production levels. Such adjustments would be based on the results of juvenile passage survival evaluations at the hydroelectric projects.

Until successfully reproducing coho salmon populations are reestablished, or a long-term coho hatchery program is developed, there are no hatchery compensation programs required in the HCPs for coho salmon.

S.5.3.9 Provisions for Unknown Impacts on Other Aquatic Species

The HCPs do not include mitigation measures for non-Plan species. However, species that actively or passively pass the project (such as bull trout) may benefit from improvements at the dams (through improved fish passage conditions). Bull trout are a threatened species in the Columbia River Basin, and although they occur in the project area, the extent of their occurrence and the project-related impacts are largely unknown. The PUDs and FERC are currently conducting informal consultation with the USFWS to assess the potential effect of project operations on bull trout.

Aquatic species that are expected to benefit from the tributary habitat improvement projects conducted under the HCPs are Pacific lamprey and resident trout species (including bull trout) that occupy the same habitats as the Plan species.

Terrestrial wildlife species that use riparian, wetland, and floodplain habitats are expected to benefit from implementation of aquatic habitat improvements in the tributaries. These improvements should increase their food supply, cover, and overall habitat area.

S.5.3.10 Monitoring and Evaluation

All three HCPs propose monitoring and evaluation of on-site measures to determine if the 95 percent juvenile dam passage survival, the 93 percent juvenile project passage survival, or the 91 percent combined adult and juvenile project passage survival metrics have been achieved (see Section 4 of the Wells, Rocky Reach and Rock Island HCPs). In addition, monitoring and evaluation of tributary habitat improvements funded by the Plan Species Account and the number and effects on other species after release of fish produced by the hatchery program would also be monitored.

S.5.3.11 Project Cumulative Effects

The anadromous salmonid mortality rates associated with passage at the projects contribute to the overall mortality of the Plan species passing other downstream hydroelectric projects. However, the salmonid survival improvements

resulting from the proposed actions would be in addition to other recovery efforts underway in the basin. The primary recovery efforts include the reasonable and prudent measures identified in the FCRPS biological opinion, Water Resource Inventory Area planning efforts, Salmon Recovery Funding Board activities, and the extensive predator control activities underway within the Columbia River Basin.

The PUDs would consider the cumulative impact effects when making land use decisions on project-owned lands to meet the conservation objectives of the HCPs, FERC license requirements, and other applicable laws and regulations. The PUDs would notify and consider comments from the signatory parties regarding land use permit applications on project-owned lands. The PUDs would also notify applicants seeking permits to use or occupy project lands or water that such use or occupancy may result in an incidental take of species listed under the Endangered Species Act, requiring advance authorization from NMFS or USFWS.

The run-of-the-river Mid-Columbia River PUD projects have limited capabilities for storing water, and are therefore unlikely to affect water quantity parameters. However, the cumulative impacts of the projects include water quality issues, particularly the effects on temperature and total dissolved gas. The PUDs would continue to work cooperatively with each other, and other entities in the region, to minimize the cumulative effects of project operations on water quality issues.

Project operations could have an effect on recreation, riparian vegetation, and wildlife species along the mainstem Columbia River, particularly for drawdown options. With the general exception of drawdown options however, project operations are not expected to substantially affect these or the other resources analyzed in this EIS, compared to existing conditions.

Off-site tributary enhancement projects could affect all the resources addressed in the EIS, depending on the location and the extent of the projects. Although such changes are expected to have environmental benefits, the effects to resources other than anadromous fish species would likely be minimal. The tributary habitat improvement projects could affect land ownership, if riparian habitat corridors are purchased or leased as mitigation activities. Other habitat improvement projects are likely to require various permits or environmental reviews.

S.5.3.12 Costs and Funding

Funding of all PUD obligations, including studies necessary to evaluate and monitor the effectiveness of those measures, would be provided directly by the PUDs from power sale revenues. It is anticipated that bonds secured by those revenues would be issued for major capital costs, such as bypass construction. Money for the Plan Species Account and the Tributary Assessment Program would also come from project revenues, with the initial contribution possibly obtained from a bond issue (see Section 7.4 of the Wells HCP and Section 7.5 of the Rocky Reach and Rock Island HCPs).

S.5.3.13 Verification of Standards

To determine if the HCPs' survival standards are being met, specific biological and statistical standards have been established in the HCPs (see Section 4.1.4 of the Wells HCP and Section 5.2.3 of the Rocky Reach and Rock Island HCPs). These standards apply to all of the evaluations to be conducted. The results would be utilized to support decisions made after Phase I of the HCPs. Efforts to determine more direct evidence of compliance with the HCP standards for all Plan species would continue during Phases II and III.

Because the juvenile fish passage survival standards cannot be verified for subyearling chinook (summer/fall chinook) or for sockeye

salmon, and the 91 percent combined juvenile and adult project survival standard cannot be verified for any of the Plan species, compliance with the juvenile dam passage survival standards would be based on calculations.

Survival studies of yearling chinook salmon and steelhead were initiated at the Wells Project in 1998 and were initiated at Rock Island Dam in 2002. Survival studies will be initiated at the Rocky Reach Dam no later than 2004. Initial verification of the 93 percent juvenile project passage or 95 percent juvenile dam passage survival standards is expected to take 3 years.

The HCPs provide a mechanism for future verification of the 91 percent combined juvenile and adult project survival standard for each of the Plan species, as the appropriate technology is developed and supported by the coordinating committees.

Wells Project

Because the Wells Project has an existing bypass system, juvenile survival studies were initiated earlier than at the other projects. Douglas County PUD conducted juvenile survival studies in 1998 using yearling chinook salmon, and in 1999 and 2000 using yearling steelhead. These studies met the biological and statistical standards established in the revised HCPs. Additionally, the Douglas County PUD conducted 3 years of fish passage efficiency evaluations (an estimate of the number of juvenile fish bypassing the project powerhouse through the surface bypass system) for the Wells Project bypass system.

The 3-year average from the yearling chinook and steelhead project survival studies was 96.2 percent. The 3-year average for the fish passage efficiency studies indicates that 92 percent of the spring-run migrants (yearling chinook, steelhead, and sockeye) and 96 percent of the summer-run migrants (summer/fall chinook) use the bypass system. Based on the best estimate of turbine and bypass system survival (90 to 93 percent and 98

to 99 percent, respectively), spring-run migrants are expected to have a juvenile dam passage survival rate of 97 to 98 percent and summer-run migrants are expected to have a 97 to 98 percent juvenile dam passage survival rate.

Throughout the term of the HCP, the 93 percent juvenile project passage survival, the 95 percent juvenile dam passage survival standard, or the 91 percent combined adult and juvenile project survival standard would be reevaluated every 10 years. It is anticipated that survival studies would be conducted for sockeye and subyearling chinook salmon, as well as adult salmon and steelhead, as technology is developed.

Funding for the Wells Tributary Conservation Plan is tied directly to the fish passage survival standard. If it is determined that the Wells adult survival rate for an individual Plan species is equal to or greater than 98 percent and the juvenile project passage survival is greater than 93 percent, the funding of the Tributary Conservation Plan would be reduced to reflect adult survival estimates for that species.

Rocky Reach Project

The Chelan County PUD is developing a surface bypass collector system for the Rocky Reach Project. This system is expected to be installed by the 2003 spring outmigration period, while survival tests would not start until 2004. Chelan County PUD would initiate 3 years of survival studies for yearling chinook salmon and steelhead to verify that the 93 percent juvenile project passage survival or the 95 percent juvenile dam passage survival standard is being met. The best available information would be used to determine whether the juvenile passage survival standards have been met for each of the remaining Plan species (e.g., survival information from surrogate species combined with measurements of fish passage through non-turbine routes). Throughout the term of the HCP, the pertinent survival standard would be reevaluated from time to time

as determined necessary by the coordinating committee.

Rock Island Project

Spill is currently the preferred juvenile bypass measure at Rock Island Dam. Beginning in 2002, Chelan County PUD would initiate 3 years of survival studies for yearling chinook salmon and steelhead to verify that either the 93 percent juvenile project passage survival or the 95 percent juvenile dam passage survival standard is being met. As is the case with the Wells and Rocky Reach projects, the best available information would be used to determine the juvenile passage survival for each of the remaining Plan species (e.g., survival information deemed sufficient by the HCP coordinating committee could be combined with measurements of fish passage through non-turbine routes to develop interim estimates of dam passage survival). Throughout the term of the HCP, the pertinent survival standard would be reevaluated from time to time as determined necessary by the coordinating committee.

S.5.3.14 Compensation for Unavoidable Project Mortality

During the development of this EIS, certain sections of the HCPs required clarification to allow for accurate analysis of the potential effects of the actions on Endangered Species Act-listed species and on other natural resources. Most of the clarifications related specifically to modification of the standards to ensure no net impact. It should be noted that HCP survival standards are fixed and compensation would not increase if the standards are not being met. For example, hatchery compensation would not be increased to 9 percent if juvenile dam passage survival were measured at only 93 percent for a given species. The 2 percent shortcoming in the juvenile dam passage survival standard would need to be addressed through improvements in dam passage survival. Likewise, if the 7 percent

hatchery compensation level is not met due to NMFS Endangered Species Act concerns, neither the dam passage survival standard, the project survival standard, nor the habitat compensation standard would be adjusted. However, failure to meet the standards by 2013 (2018 for the Wells Project) would allow parties to withdraw from the HCP agreements.

Although the compensation levels would not increase as a result of not meeting the survival standards, hatchery compensation for the Wells Project could be reduced if the survival standards are exceeded. However, if the survival standards are exceeded at Rock Island or Rocky Reach dams, Chelan County PUD may reduce the amount of spill to levels which will continue to meet the survival standards of the HCPs, as indicated by an additional series of survival studies.

S.5.3.15 Hatchery Compensation Plan Issue

During the development of the HCPs, NMFS determined that the 7 percent hatchery compensation levels may adversely affect wild salmon populations under certain conditions.

Therefore, until the specific details of the compensation programs were developed (including identification of appropriate broodstock, maximum percentages of the wild populations that can be trapped for broodstock, and the total number of fish produced through artificial means), NMFS could not guarantee that the 7 percent compensation level would satisfy Endangered Species Act requirements.

To address the Tribes' concerns regarding hatchery production levels, subsequent HCP negotiations resulted in an agreement to provide the PUDs with a 7 percent hatchery production guarantee through 2013. In 2013 the parties to the HCP agreements shall have an opportunity to review and make modifications to the hatchery compensation component of the HCP agreements.

Based on the results of the program review in 2013, the program could be changed at that time, or in subsequent reviews scheduled for every 10 years.

To minimize the potential impacts to wild fish from the Hatchery Compensation Plans, the PUDs would implement specific elements of the hatchery program consistent with overall objectives of rebuilding natural populations, and achieving no net impact to the Plan species. Specific objectives may include contributing to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecologic integrity, and supporting harvest objectives.

Due to the increased emphasis on developing hatchery programs that focus on rebuilding natural populations, NMFS believes (pending completion of its review of the HCPs) that the initial hatchery production levels outlined in the HCPs are unlikely to jeopardize the continued existence of the listed species in the near term. However, there is still some uncertainty over the long term. As a result, it was agreed that the initial hatchery production levels necessary to compensate for 7 percent unavoidable mortality at the projects would be maintained until a comprehensive review is conducted in 2013. (Chelan County PUD hatcheries are compensating for a 14 percent juvenile mortality in the period running through 2013.) These production levels are based on adult return rates during the baseline period, the 7 percent compensation requirement, and baseline adult to smolt survival rates for existing Mid-Columbia River hatcheries. In addition to the program review in 2013, additional reviews would occur every 10 years during the term of the HCPs.

S.5.3.16 Other Options Considered

Similar to Alternative 2, Alternative 3 could include project reservoir drawdown after 2013 for the Rocky Reach and Rock Island projects or after 2018 for the Wells Project. Either the

USFWS or NMFS could pursue this option under certain circumstances, including if: (1) no net impact has not been achieved or has been achieved but has not been maintained, (2) the Plan species are not rebuilding and the project is a significant factor in the failure to rebuild, or (3) is agreed to by the PUDs.

S.5.3.17 Recent HCP Policy Revisions

On June 1, 2000, USFWS and NMFS published a final addendum to the *Habitat Conservation Planning and Incidental Take Permit Processing Handbook* (USFWS and NMFS 2000). This addendum, which is also known as the five-point policy guidance, provides clarifying direction on five issues brought forth from recent HCPs implemented throughout the United States. The following sections describe how the applicant HCPs meet the HCP addendum.

Biological Goals and Objectives

The addendum recommends that biological goals and objectives be incorporated in HCPs. These goals may be either habitat- or species-based. Species-based goals are expressed in terms specific to individuals or populations of that species. The performance standards represent the biological goals and objectives for the HCPs (i.e., the HCP standards). These standards require specific survival goals based on the population passing through each project. In addition, incidental mortality is mitigated through hatchery production and habitat improvements to achieve an overall no net impact standard.

Adaptive Management

The use of an adaptive management strategy is recommended to (1) identify uncertainties related to quantifying the achievement of goals and objectives of the HCPs, as well as the questions that need to be addressed to resolve these uncertainties; (2) develop alternative strategies and determine which experimental strategies to

implement; (3) integrate a monitoring program that is able to detect the necessary information for strategy evaluation; and (4) incorporate feedback loops that link implementation and monitoring to a decision-making process that results in appropriate changes in management. Adaptive management would be incorporated into the HCP monitoring programs that provide the feedback necessary to determine the effectiveness of various approaches being implemented to increase fish survival. Throughout the term of the HCP, what is learned would be used to adjust conservation measures.

Monitoring

HCP handbook guidance on monitoring recommends that the monitoring program reflect the measurable biological goals and objectives. The monitoring programs developed under the Mid-Columbia River HCPs are three-fold: (1) confirm fish survival through the dams (validation monitoring), (2) evaluate the effectiveness of on-site mitigation measures implemented to improve fish survival (effectiveness monitoring), and (3) confirm that the on- and off-site mitigation measures are applied correctly (implementation monitoring).

Permit Duration

Factors to be evaluated when determining permit duration include the time line of the proposed activities and the expected positive and negative effects on covered species associated with the proposed duration. The HCP terms generally compliment the term of a project operating license, but more importantly reflect a desire to provide long-term protection assurances for the Plan species that also account for oceanic condition changes that may occur over a longer period of time.

The HCP handbook addendum recommends a 90-day public comment period for large scale, regional or complex HCPs. The addendum notes that 60 days would be appropriate if the applicant has taken steps to involve the public early in the process. In this process, the public was provided with four months to comment on the draft EIS; interested parties participated directly in developing the revised HCPs over the course of 6 months; and an additional comment period of 30 days was provided on the revised HCP permit applications.

S.6 ACTIONS COMMON TO ALL ALTERNATIVES

Only those project operations that affect fish passage would be altered, if necessary, to assist in increasing the overall salmon and steelhead survival rates. Studies to evaluate and improve fish passage have been ongoing since the dams were constructed. As a result, the key factors influencing fish passage have already been identified. Project operations that are included under all of the alternatives are:

fishways, fishladders, fish bypass, turbine operations, predator control, hatcheries, and spill.

The four tributaries where funds for the Plan Species Account would be directed under the HCP (Wenatchee, Entiat, Methow, and Okanogan) have threatened (bull trout) and endangered (spring-run chinook and steelhead) species. Numerous efforts are being, or will be, implemented to improve fish survival and breeding opportunities in the streams that are unrelated to the operation of the Wells, Rocky Reach, and Rock Island dams or the HCPs. These separate improvement activities (not funded by the PUDs) would continue under all alternatives.

S.7 ALTERNATIVE COMPARISON

Because all three of the alternatives strive to improve fish survival at the dams, this section describes both the environmental differences among the alternatives at the project site and the procedural differences for implementing the alternatives, as shown in Table S-3 and described below.

The most significant differences among the alternatives are the scope of the species covered, the statutory obligations satisfied, the parties that support the alternatives, and the timing and certainty for implementation. For example, under Alternative 1, current FERC license requirements would address all species but may or may not address the additional requirements of the Endangered Species Act. Alternative 2 would result in an additional protection plan for anadromous salmonid species but is primarily concerned with the protection and recovery of Endangered Species Act-listed Upper Columbia River steelhead and spring-run chinook salmon. A new Endangered Species Act consultation would occur at the time each project is relicensed, or when significant new information is available that indicates that existing protection measures are not adequate for the listed fish and a reopener clause proceeding is initiated. This would help in the protection of anadromous salmonids. Finally, Alternative 3 (Proposed Action) represents longterm settlements of the anadromous salmonid issues for each project under the current licenses and at relicensing for all anadromous salmonid species in the project area. Alternative 3 would be effective for a 50-year term, although comprehensive reviews of the programs and species status would occur every 10 years.

S.7.1 AFFECTED SPECIES

S.7.1.1 Alternative 1 (No-Action)

For purposes of comparison only, it is assumed that protection for the listed and non-listed

anadromous salmonid species would be limited to existing measures under current FERC licenses and agreements. Existing measures, however, may not prevent the extinction of listed species, nor are they expected to increase the populations of non-listed species above current levels.

S.7.1.2 Alternative 2

Alternative 2 includes the protective measures identified in Alternative 1, as well as additional measures to protect listed anadromous species. Authorities afforded to NMFS under the Endangered Species Act would apply to Upper Columbia River steelhead, Upper Columbia River spring-run chinook salmon, and Mid-Columbia River steelhead. Protection for other Endangered Species Act-listed species (including bull trout) that might be impacted by the Mid-Columbia River hydroelectric projects would be addressed through separate but similar actions to those identified for Alternative 2.

NMFS and FERC also have obligations to protect anadromous species through the Federal Power Act through the relicensing or license reopener procedures. As with the other alternatives, additional protection for non-listed anadromous species is expected through these proceedings. However, the protection measures are not expected to be as comprehensive as those that apply to the listed species.

S.7.1.3 Alternative 3

The HCPs provide the same level of protection for sockeye, summer/fall-run chinook, and coho salmon as they provide to the Endangered Species Act-listed species. Although the wild population of coho salmon has been extirpated from the action area, the HCPs provide measures to protect reintroduced populations. Although the impacts

TABLE S-3. COMPARISON OF ALTERNATIVES FOR ANADROMOUS SALMONID CONSERVATION MEASURES

ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Endangered Species Act Compliance	Continue with existing measures under current license conditions ¹	Section 7(a)(2) for ESA-listed species for all three projects	Section 10(a)(1) for all Plan species (applies to those species which are currently listed as well as those that could be listed in the future)
Duration of Each Alternative	50 years ²	Same as Alternative 1 ²	50 years subject to withdrawal and termination provisions
Species Covered	All anadromous salmonid species	Same as Alternative 1, but additional measures would focus primarily on ESA listed species.	Same as Alternative 1
Protection Measures	Limited spill and bypass measures, continued operation of adult fishways	Additional project operational and structural modifications for listed species and potentially additional protection measures for non-listed anadromous fish through the issuance of a new license; determination and implementation of measures would depend on ESA consultations, negotiations, and Federal Power Act authorities.	Following HCP approval, immediate implementation of additional project operational and structural modifications for all Plan species, as well as habitat improvement measures
Implementation Timing	Protection measures currently being implemented	Protection measures to be implemented during relicensing, license amendments or under reopener clause proceedings, but subject to Section 7(a)(2) consultations; implementation would occur following FERC approval of the measures, which typically occurs up to 5 years following commencement of formal ESA consultation	Implemented immediately following HCP approval
Performance Standards	Currently based on fish passage efficiency for specific measures, such as a specified spill level for a fixed period of time or until moneys in the Fish Conservation Account are exhausted (no project or species level standards)	Same as Alternative 1, except for the likely development of appropriate survival standards for listed species through ESA consultations, as well as some potential for developing survival standards for non-listed anadromous salmonid species through the Federal Power Act	No net impact for all Plan species - 91% combined adult and juvenile project (reservoir and dam) passage survival, or 93% juvenile project passage survival, or 95% juvenile dam (forebay, dam, and tailrace) passage survival; compensation to obtain no net impact also includes up to 7% hatchery programs and 2% to tributary programs

TABLE S-3. COMPARISON OF ALTERNATIVES FOR ANADROMOUS SALMONID CONSERVATION MEASURES (CONTINUED)

ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Project Lead for Identifying and Implementing Protection Measures	FERC through the existing coordinating committees	Same as Alternative 1 or through new license conditions	HCP coordinating committees
Location of Fish Protection Measures	Project area, including reservoir, dam structures, tailrace, and hatcheries	Same as Alternative 1	Same as Alternative 1 and additionally including Wenatchee, Entiat, Methow, and Okanogan Rivers and tributaries
No Surprises Policy	Not applicable	Not applicable	Applicable, subject to certain circumstances defined in the withdrawal provisions of the HCP agreements
Continued Studies to Assess Survival	Needed to verify fish passage measures at Rock Island and Rocky Reach dams	Same as Alternative 1	At least 3 years of evaluation for each Plan species, and periodic reevaluations every 10 years or as determined by the HCP Coordinating Committees
Monitoring Following Statement/Permit Issuance	Not applicable	As needed to ensure effectiveness of measures and status of salmonid species	Periodic monitoring to verify survival for all Plan species
Future Provisions for Other Aquatic Species	Would occur under relicensing or under existing license reopener clauses	Same as Alternative 1, although Endangered Species Act-listed species would be covered under separate consultations	Same as Alternative 2
Hatchery Compensation	Continued hatchery funding at present level, for inundation compensation levels and ongoing unavoidable losses (hatchery compensation can be adjusted for Wells based on actual losses)	Same as Alternative 1, although production levels may be reduced at any time based on potential effects to listed species	Continued hatchery funding for inundation compensation levels; hatchery funding would be established to mitigate for unavoidable losses; initially, mitigation would be set to achieve a 7 percent compensation level but could be adjusted periodically based upon the results of survival studies; additional survival reevaluations would take place every 10 years

TABLE S-3. COMPARISON OF ALTERNATIVES FOR ANADROMOUS SALMONID CONSERVATION MEASURES (CONTINUED)

ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Tributary Improvements	No PUD-funded improvements	Same as Alternative 1	PUD contributions to the Plan Species Account would pay for projects that improve salmon and steelhead habitat in the Wenatchee, Entiat, Methow, and Okanogan River Basins, as well as the Mid-Columbia River mainstem; the combined funding over the 50-year term of the HCPs is over \$46.5 million, and is specified and guaranteed in the HCPs
On-Site Protection	Measures		
Wells	Adult Passage: Continue operation and maintenance of adult fishways, evaluate and improve fishway operations, if adult fish passage problems are identified, develop solutions to the problems	Adult Passage: Same as Alternative 1 or as needed to prevent the extinction of listed species; conduct spawning success evaluations, operate surface bypass system during adult steelhead and spring-run chinook migration periods and downstream kelt passage period	Adult Passage: Same as Alternative 1, with the additional requirement to meet the 91% combined adult and juvenile survival standards for all Plan species
	Juvenile Passage: Evaluate and control total dissolved gas, continue, operate surface bypass system to achieve 80% fish passage efficiency for spring and summer migrants	Juvenile Passage: In addition to measures in Alternative 1: operate the turbines as efficiently as possible, operate surface bypass system 24 hours/day for up to 99% of juvenile migration, increase spill as needed to improve survival but limited by dissolved gas	Juvenile Passage: Meet 93% project passage survival or 95% dam passage survival for all Plan species by increasing effectiveness of juvenile bypass system, spill gates, predator control, and turbine usage, or through other measures
Rocky Reach	Adult Passage: Continue to operate and maintain adult fishladders, operate powerhouse units within 1% of peak efficiency	Adult Passage: Continue operation and maintenance of adult fishways, evaluate and improve fishway operations, conduct modeling and develop solutions for adult fish passage problems, use spillway flow configurations to optimize adult fishway attraction flows, provide safe passage for adult fallbacks and kelts, evaluate biological impacts of adult passage	Adult Passage: Same as for Wells (above)

TABLE S-3. COMPARISON OF ALTERNATIVES FOR ANADROMOUS SALMONID CONSERVATION MEASURES (CONTINUED)

ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
	Juvenile Passage: Operate the turbines as efficiently as possible during the migration seasons, spill 15% of daily river flow for 42 days of the spring migration period and 10% for 34 days during the summer migration; evaluate and construct a permanent bypass system and replace old turbine runners, control total dissolved gas, continue predator control measures, monitor passage and total dissolved gas levels to meet requirements	Juvenile Passage: Same as Alternative 1, except for additional spill to improve juvenile fish passage survival rates to cover up to 99% of the migration period, but limited by dissolved gas levels; consider additional or alternative juvenile bypass options such as a sluiceway	Juvenile Passage: Construct and operate a new juvenile bypass facility and spill 15% of the daily average river flow, over 95% of the migration period of each Plan species (in addition, spill is increased to 25% for three weeks during the spring migration period to further protect sockeye), or as necessary to meet the survival standards listed above for Wells Dam, other operational criteria would be similar to Alternative 1
Rock Island	Adult Passage: Continue to operate and maintain adult fishladders	Adult Passage: Same as for Rocky Reach (above)	Adult Passage: Same as for Wells (above)
	Juvenile Passage: Provide spill as requested by Fishery Agencies and Tribes through the Fish Conservation Account (currently assessed at about \$3.2 million), evaluate fish guidance efficiency, control gas abatement, continue predator control measures	Juvenile Passage: Increase spill to improve juvenile fish passage survival rates to cover up to 99% of the migration period, but limited by dissolved gas levels; enhance spillway passage efficiency, preferentially use Powerhouse 2 turbines, and minimize use of Nagler turbines	Juvenile Passage: Spill 20% of the daily average river flow, over 95% of the migration period of each Plan species; also strive to meet the survival standards listed above for Wells
Dispute Resolution	Disputes resolved by Wells, Rock Island, and Mid-Columbia Coordinating Committees or FERC and/or in court	Disputes are resolved by NMFS, FERC, and/or in court	Disputes resolved by coordinating committees or policy committees, if no resolution is reached, procedures would be similar to Alternative 2
Additional Protection Measures	As negotiated during relicensing or license re-opener clauses	Other measures as required by FERC and NMFS to ensure protection of salmonid species and recovery of the listed species	As determined by the HCP coordinating committee to meet the survival standards for all Plan species

Alternative 1 (no-action alternative) represents existing baseline conditions for comparative purposes only. The measures implemented under Alternative 1 may not comply with the Endangered Species Act.

² Considered for comparison purposes only.

to Mid-Columbia River steelhead² are likely limited to water quality issues, this species is not specifically addressed in the HCP agreements. Protection for bull trout or other Endangered Species Act-listed species would be addressed under separate Section 7 consultations.

S.7.2 PROCEDURAL DIFFERENCES

S.7.2.1 Alternative 1 (No-Action)

Provisions of this alternative would be implemented under existing FERC license conditions, which currently include use of several coordinating committees. The committees consist of members representing fishery agencies, Tribes, and PUDs. The protection measures implemented through this process require unanimous consent of all parties. This has resulted in contested proceedings and legal debates among the parties that have significantly delayed implementation of fish protection measures. This alternative does not contemplate additional protection for listed or unlisted anadromous fish, and may not satisfy Endangered Species Act requirements.

S.7.2.2 Alternative 2

In addition to measures implemented through existing FERC license conditions, NMFS has the legal authority under the Endangered Species Act to recommend additional measures necessary to ensure that any FERC action affecting the projects does not jeopardize the continued existence of listed species. Such actions include relicensing proceedings, license amendments and proceedings under the reopener clauses. NMFS may also identify the most appropriate measures to be taken at each project and modify the

measures as needed if species continue to decline. FERC, as the action agency, must include these measures in the license to obtain exemption from the take prohibitions as described under Section 9 of the Endangered Species Act. Under Section 7, NMFS has a legal responsibility to provide the benefit of the doubt to listed species with respect to gaps in the information base.

If FERC or the PUDs disagree with NMFS's decisions under this process, lengthy legal proceedings may ensue. During these proceedings, measures in addition to those already included in the FERC-issued operating licenses and settlement agreements are not likely to be implemented.

Species not listed under the Endangered Species Act would be addressed through NMFS's authorities under the Federal Power Act and the Magnuson-Stevens Fishery Conservation and Management Act, although these species might also benefit from actions implemented for the listed species. In addition, FERC relicensing or license reopener proceedings are expected to result in greater protection measures for all anadromous species.

S.7.2.3 Alternative 3

According to HCP provisions, the primary authority to determine the appropriate protection measures for each Plan species is provided to the coordinating committees (comprised of the PUD responsible for the HCP, NMFS, and each of the signatories to the agreement) for a joint decision on the appropriate measures. In the case of a dispute, if the coordinating committee cannot reach a unanimous agreement within 20 days, the dispute would be referred to the policy committee. If the policy committee cannot reach a unanimous agreement within 30 days, the HCP parties may pursue any other right that they might otherwise have to affect a decision, which would be similar to the dispute resolution options available under Alternatives 1 and 2.

² This Evolutionarily Significant Unit includes all naturally spawned populations of steelhead in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington; but excluding steelhead from the Snake River.

Because the HCPs establish specific actions, responsibilities, and duties to be carried out by the PUDs, each of the signatories to the agreements agrees not to institute any action under the Endangered Species Act, the Federal Power Act, the Fish and Wildlife Coordination Act, the Pacific Northwest Electric Power Planning Conservation Act, Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act, or Title 77 RCW with regard to the Plan species for these three projects (except as noted for the dispute resolution process). NMFS's No Surprises policy (which ensures the PUDs that NMFS would not request additional measures during the term of this agreement) would be in effect. However, the No Surprises policy would not affect the ability of NMFS to withdraw from the HCP agreements under the withdrawal provisions. While the No Surprises policy ensures that the HCP goals remain the same, the measures needed to achieve the goals could change.

S.7.3 TIME FRAME

S.7.3.1 Alternative 1 (No-Action)

Fish protection measures included in this alternative would occur throughout the term of the FERC-issued operating licenses. Project operations would continue as occurs presently regardless of future listings or delisting. FERC license periods are typically 30 to 50 years, and the Wells, Rocky Reach, and Rock Island projects would be relicensed over the next 26 years. It is recognized that additional fish protection measures could be implemented during relicensing and potentially through reopener clause negotiations, as described above. However, the pursuit of additional protective measures through these venues is evaluated in Alternative 2. Thus, for comparative purposes, it is assumed that the time frame evaluated for Alternative 1 is the same as the 50-year HCP term, and that no additional measures are adopted during that time period.

S.7.3.2 Alternative 2

The time frame is the same as Alternative 1.

S.7.3.3 Alternative 3

The HCPs would be in effect for a 50-year period beginning in approximately 2003, the date that the agreements are expected to be adopted by FERC as amendments to the FERC licenses (currently expected to be June 2003 through May 2053), except for defined termination procedures.

S.7.4 GOALS AND OBJECTIVES

S.7.4.1 Alternative 1 (No-Action)

This alternative may not provide specific provisions to ensure the continued existence or recovery of Endangered Species Act-listed fish species. Protection measures would continue to be implemented in accordance with existing FERC license articles and settlement agreements. Goals and objectives tend to be specific for each measure at each dam (i.e., no outcome-based performance standards).

S.7.4.2 Alternative 2

This alternative includes regulatory options under the Federal Power Act and Endangered Species Act. No specific project goals are identified, although the general consensus is to maximize salmonid survivability through the projects. Although outcome-based performance (survival) standards are likely to be established for the listed species, it is uncertain whether similar standards would be set for non-listed species.

S.7.4.3 Alternative 3

The HCPs provide long-term agreements to protect the Endangered Species-listed and non-listed salmon and steelhead, with the goal of having no net impact to all the Plan species. The no net impact standard would be achieved

through project-specific protection measures, hatchery production, and tributary habitat enhancement projects.

S.7.5 <u>IMPLEMENTATION SCHEDULE</u>

The three alternatives have different schedules for the implementation of the conservation measures, based on the mechanism used to establish the measures. The conservation measures included under Alternative 1 represent existing conditions and are therefore currently being implemented for all species, although the operational criteria for Rocky Reach Dam (provided by the Fourth Revised Interim Stipulation) have expired. As a result, additional negotiations would be required to develop new operational criteria for Rocky Reach Dam. However, the biological opinion issued by NMFS for the construction and operation of the permanent bypass system would be the likely starting point.

Additional measures implemented under Alternative 2 during the established 50-year timeline would be accomplished through the procedures available in the Federal Power Act, including relicensing or license reopener procedures. It is unknown when additional conservation measures would be implemented under Alternative 2, except during the established relicensing dates. However, previous negotiations have typically taken a number of years to reach agreement. There is also the potential for requiring legal proceedings to establish the conservation measures.

Additional Endangered Species Act consultations would be needed to establish conservation measures for the listed species. It is uncertain how long it would take to complete the consultation proceedings and the subsequent license amendment processes.

A number of the provisions provided under Alternative 3 have already been voluntarily implemented by the PUDs based on the staggered effective dates of Chelan County PUD's HCPs and Douglas County PUD's expectation that the HCPs will be approved and permitted by the appropriate regulatory agencies. The remaining provisions would be implemented when the HCPs are amended to the FERC licenses. As a result, no additional negotiations or consultations would be required to begin implementation of the conservation measures. In addition, legal challenges between the PUDs and the agencies would be substantially minimized or eliminated.

S.7.6 ADDITIONAL MEASURES

S.7.6.1 Alternative 1 (No-Action)

This alternative does not provide a procedure to require implementation of mitigation measures beyond the project's boundaries (i.e., tributary habitat improvements). Under Alternative 1, hatchery supplementation is addressed through the existing settlement agreements and license articles.

S.7.6.2 Alternative 2

Under Alternative 2, additional protection would likely be provided to the Endangered Species Act-listed fish by NMFS. If NMFS determines that the current hatchery production levels would compromise the genetic integrity of Endangered Species Act-listed fish, the production levels would be reduced. Such a determination could occur at anytime, because it would be considered significant new information warranting reinitiation of consultation. Other measures could also be implemented at any time through consultations based on new information.

Provisions of the Clean Water Act, Federal Power Act, Northwest Power Planning Act, Tribal treaties, and other laws and statutes are available under Alternative 2 to protect and restore Upper Columbia anadromous fish through increased operational and structural measures and supplementation.

S.7.6.3 Alternative 3

The HCPs include a funding process for the protection and restoration of Plan species' habitat within the Columbia River watershed (from the Chief Joseph project tailrace to the Rock Island Project tailrace) and in the Okanogan, Methow, Entiat, and Wenatchee River watersheds. In addition, hatchery compensation plans guarantee funding and capacity to meet the 7 percent compensation level necessary to achieve no net impact. Hatchery compensation levels, with few exceptions, would not change until 2013, and every 10 years thereafter.

Similar to Alternative 2, provisions of other laws, statutes, and Tribal treaties are available under

Alternative 3 to protect and restore Mid-Columbia anadromous fish through increased operational and structural measures and supplementation. However, specific provisions in these laws and statutes that are under the jurisdiction of NMFS (and other signatory parties) would be subject to the terms and conditions of the HCPs.

S.7.7 OTHER ENVIRONMENTAL DIFFERENCES

Table S-4 provides a summary comparison of how the alternatives affect other environmental resources in the project area. This information is further described in Chapter 4.

S.8 Preferred Alternative

The proposed action (Alternative 3) is the preferred alternative of the project proponents (Douglas County and Chelan County PUDs) and NMFS, as well as USFWS, WDFW, and the Colville Tribe. NMFS will describe its preferred alternative and the rationale for selecting it in a ROD issued following review of this FEIS. The review by NMFS is guided by both the Endangered Species Act and NEPA requirements. The major NEPA-related issues that NMFS considered in making its decision were:

- Was the environmental review process adequate?
- Were the impacts adequately discussed and significant adverse impacts mitigated?
- Were all reasonable and appropriate alternatives to the proposed action considered?
- Are there significant unavoidable adverse impacts associated with the preferred alternative?

- What were the values that were considered, and what is the basis for the decision?
- Are there any outstanding unresolved issues?
- Will the preferred alternative result in the irrevocable commitment of Federal resources?
- Does the preferred alternative meet the applicants' purpose and need?
- What are the major differences between the preferred alternative and the proposed action?

In addition to analyzing all human and biological resources potentially affected by the preferred alternative, the major Endangered Species Act issues that NMFS considered were related to the overall protection and recovery of the salmon and steelhead species covered by the incidental take permit. To document its analysis and decision making, NMFS would issue a biological opinion to assist in deciding whether the HCPs satisfy the requirements of Section 10(2)(B) of the Endangered Species Act. The biological opinion analysis by NMFS will involve:

- determining the biological requirements within the proposed action area,
- determining the status of the species within the action area,
- determining the factors affecting the species environment within the action area,
- determining the effects of the proposed action on species-level biological requirements, and
- evaluating the cumulative effects associated with the proposed action.

Prior to amending the project licenses, FERC is expected to consult with USFWS to evaluate any impacts on listed species not included as Permit species (e.g., bull trout). The FERC is also expected to initiate consultation with NMFS at this time to evaluate any impacts on listed anadromous species. However, it is assumed that absent any new information, FERC's proposed license amendments would be identical to the proposed actions already evaluated in the biological opinions on NMFS's issuance of the incidental take permits and the NMFS's findings would be identical.

The ROD for this EIS will certify the adequacy of the HCPs' environmental review process and will incorporate the requirements of the permit, including the mitigation commitments of the applicants.

TABLE S-4. COMPARISON OF ENVIRONMENTAL CONSEQUENCES

A	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
nd Features, Geology, ar	nd Soils		
Project Area Soils	Same as existing conditions.	Same as Alternative 1. If reservoir drawdown occurs, portions of the river cross-sectional areas would decrease to the original size of the river. In the short-term, riparian and shoreline areas would be disturbed and eventually mainstem spawning, incubation, and rearing habitat would be increased.	Same as Alternative 2.
Reservoir Erosion and Sedimentation	Same as existing conditions.	Same as Alternative 1. If reservoir drawdown occurs, erosion and reservoir turbidity would initially increase over the short term and damage aquatic habitat conditions, with the greatest damage occurring during the first 4 to 7 years. Turbidity would decrease over time, and habitat conditions would improve. However, increased turbidity could also provide cover for juvenile fish from predators. Natural river sediment transport regimes would be restored, which could increase salmonid production through improved spawning and rearing habitat. Increased rates of sediment deposition would take place in the reservoir immediately downstream of the drawn down reservoir.	Same as Alternative 2.
Associated Tributaries	Geologic conditions conducive to fish habitat are expected to improve from independent local and State funded WRIA fish habitat enhancement projects.	Same as Alternative 1. If reservoir drawdown occurs, tributary channel mouths would erode each year. However, additional spawning habitat would likely be provided at the confluence with the mainstem.	Same as Alternative 2, with additional improvements to the geomorphic condition the stream channel through the PUD-funde tributary habitat enhancement programs.
Columbia River System/Cumulative Effects	Same as existing conditions.	Same as Alternative 1. If reservoir drawdown occurs, increased sediment and turbidity over the short-term particularly in the reservoirs immediately downstream of the drawn down project.	Same as Alternative 2.

TABLE S-4. COMPARISON OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

ALTERNATIVE 1 ALTERNATIVE 2 ALTERNATIVE 3

Fisheries Resources

Anadromous Salmonids and Other Listed Species (bull trout)

Juvenile Migration/Survival **Standards**

Project-specific fish passage standards, no additional specific protection measures for threatened or endangered species. Protection for listed and non-listed species would be provided by laws and statutes other than the ESA.

Wells Dam: Provide a non-turbine passage route (juvenile bypass system) to pass at least 80% of spring-run outmigrants and 70% of summer outmigrants.

Rocky Reach Dam: Provide safe (less than 2 percent mortality) non-turbine passage route (juvenile bypass or spillway passage) for 80% of juvenile migrants over 90% of the migration period.

Rock Island Dam: Fund an account to purchase spill, as requested by fish agencies and the Tribes, to an annual revenue loss of \$2.05 million (in 1987 dollars to be adjusted for inflation).

Maintain and operate fishladders according to criteria established in the existing settlement agreements or by the fishery agencies. Project-specific standards, with no specific protection measures for threatened or endangered species. Protection for all species would be provided by laws and

statutes other than the ESA.

Same as Alternative 1. Additional measures may be required under FERC licensing or ESA requirements that are likely to include increased use of spill to improve juvenile fish passage survival. Bull trout protection would be provided through consultation with USFWS.

Wells Dam: Potentially increase the use of spill and extend the operational time frame of the juvenile bypass system to up to 40% of daily average flow through 99% of the juvenile migration periods.

Rocky Reach Dam: Same as Wells Dam above.

above.

As required to minimize the impacts to salmonid species. The PUDs would each consult with FERC and NMFS for anadromous salmonids, and with USFWS for bull trout.

No net impact standard - 91% combined adult and juvenile project passage survival, 93 % juvenile project survival, or 95% juvenile dam passage survival for all Plan species. Compensation to obtain no net impact also includes 7% to hatchery programs and 2% to tributary programs. Bull trout protection would be similar to Alternative 2.

No net impact standard - 91% combined adult

and juvenile project passage survival, or 95%

impact also includes 7% to hatchery programs

juvenile dam passage survival for all Plan

species. Compensation to obtain no net

and 2% to tributary programs. Bull trout

protection would be similar to Alternative 2.

Rock Island Dam: Same as Wells Dam

Adult Migration/ Survival Standards

TABLE S-4. COMPARISON OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

A	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Hatchery Production	Hatchery mitigation for initial loss of habitat from dam construction would continue over the long term. Hatchery funding for unavoidable losses from fish passage would follow existing settlement agreements.	Same as Alternative 1. Production could be reduced at any time if significant impacts to listed species are likely to occur. Production could be reduced based on actual fish passage losses. Production would be adjusted at relicensing.	Same as Alternative 1, except the initial production levels would be based on compensating for assumed unavoidable project passage mortality. Production levels would not change until at least 2013. Compensation for unavoidable losses at Well Dam would be adjusted to 3.8% for yearling chinook and steelhead and 7% for sockeye and subyearling chinook from the currently assumed 14% rate for all species. Exact production levels based upon the actual numbers of returning adults. Hatchery production would not be less than that specified to address initial project inundation.
Independent (Non-PUD Funded) Tributaries Habitat Improvements	Habitat improvements could occur through the implementation of non-PUD funded projects through Federal, State, and local agency funding, specifically WRIA-funded projects.	Same as Alternative 1.	Same as Alternative 1.
PUD-Funded Habitat Improvements	None.	Same as Alternative 1.	\$46.5 million (1998 dollars) additional funding provided through the HCPs to compensate for the 2% unavoidable project mortality.
Monitoring	At Wells, run timing, total dissolved gas, and system efficiency monitoring would continue. At Rocky Reach and Rock Island, only monitoring to ensure facility modifications are achieving criteria identified in license articles, settlements, and stipulations.	Same as Alternative 1, with additional survival studies for Endangered Species Actlisted juveniles and adults.	Studies necessary to verify that standards are being met for all Plan species will take place during Phase I, periodic monitoring to verify that standards continue to be met during Phase III, and periodic monitoring in Phase II to evaluate survival improvements.
Drawdown	Drawdown cannot be required under existing licenses.	Drawdown could increase survival rates of migrating juvenile fish over the long term. However, lower water levels could initially increase predator density and predator/prey encounters. Over the short term, drawdown would decrease water quality, fish habitat, and foraging opportunities, and likely affect survival rates. Only an option at relicensing. Also see Land Features, Geology, and Soils section.	Same as Alternative 2, although this is unlikely to occur under the HCPs. However, the Services have the option of withdrawing from the HCPs to pursue drawdown or dam removal options under certain provision of the HCPs.

TABLE S-4. COMPARISON OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Bull Trout	No specific measures are identified to protect bull trout.	Protection measures as required to recover the species under the ESA (Section 7 consultation).	Same as Alternative 2.
QAR Analysis	Based on analysis of Upper Columbia River spring-run chinook salmon and steelhead, the return rates for spring-run chinook salmon have been trending down at a loss rate of 5 to 10% per year. Although complicated by the natural spawning of hatchery fish, wild steelhead populations in the Wenatchee and Entiat Rivers are trending down at a similar rate as the chinook populations, while the Methow River population is trending downward at a faster rate	Although maximizing survival at each of the PUD dams will increase the return rates of spring-run chinook salmon and steelhead, populations will continue to decline without reductions in non-hydro system related impacts (including higher ocean survival), although at a slower rate than Alternative 1.	Achieving the project survival and habitat improvement standards identified in the proposed HCPs will increase Mid-Columbi. River reach survival by approximately 22 to 35% for steelhead and 27 to 45% for spring run chinook salmon. Under these survival rates, populations will continue to decline without reductions in non-hydro system related impacts, although at a slower rate to Alternatives 1 or 2, if survival conditions continue as they were for brood years 1980 1994. Commitments to habitat productivity addition to dam passage survival increases will increase survival rates by an additional to 10% over Alternative 2. Under the longterm scenario, achieving the survival standards in the HCPs alone would reduce the risk of extinction to acceptable levels. (The effects of long-term supplementation have not been analyzed.)

Other Species of Concern or Importance (lamprey, sturgeons, cutthroat trout, game species, etc.)

Project Area

No change expected over existing conditions.

Improvements to fish bypass systems or an increase in spill volumes might occur. These measures would likely reduce the turbine entrainment of some resident species.

Specific sections of the bypass systems could disproportionately affect some species (e.g., impingement of lamprey on turbine intake screens. Increased spill and resultant elevated levels of TDG may have negative impacts on the reproductive success of sturgeon and may impact the long-term health or food base of aquatic species located within the action area.

Spill requirements could change dependent on efficiency of juvenile bypass systems and/or meeting survival standards. Meeting the survival standards for all the Plan species would likely provide a wider range of protection for other species.

TABLE S-4. COMPARISON OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
		Drawdown would affect habitats of reservoir fish, and access to and from tributary streams for migratory species. Habitat for species adapted to free-flowing river conditions (e.g., cutthroat trout) would increase or improve, while habitat for species better suited for reservoirs (e.g., bass) would diminish.	Same as Alternative 2.
Associated Tributaries	No direct effect. Habitat improvements could occur through the implementation of non-PUD-funded projects through Federal, State, and local agency funding.	Same as Alternative 1.	Habitat improvements funded by the HCP Plan Species Account would likely benefit but rout, cutthroat trout and have added benefits to the health and productively of all native fis species that occur in the tributary streams.
Columbia River System/Cumulative Effects	No changes expected over existing conditions.	Same as Alternative 1.	Same as Alternative 1.
Water Quantity			
Project Area	No change in flows.	Amount of spill could increase to improve juvenile fish passage survival, particularly for listed species. Drawdown would increase water velocity.	Amount of spill could change dependent on efficiency of juvenile bypass systems and/or meeting the survival standards. However, water quantities would not be substantially altered. Effects from drawdown would be the same as Alternative 2.
Associated Tributaries	No effect. Some non-PUD-funded projects may help to increase water quantity in the tributaries.	Same as Alternative 1.	Additional funding by the PUDs through the Plan Species Account would likely provide for more water conservation projects and more improvements in tributary flows.
Columbia River System/Cumulative Effects	No changes expected over existing conditions.	Same as Alternative 1.	Same as Alternative 1.
Water Quality			
Project Area Total Dissolved Gas	No change expected over existing conditions	Some improvement expected as Ecology imposes TMDL for Clean Water Act compliance and other measures (e.g., spill deflectors) are implemented at relicensing. Spill and total dissolved gas levels could increase if needed to improve anadromous fish passage efficiency or survival rates.	Same as Alternative 1, although spill could increase as needed to meet survival standards, resulting in an increase in total dissolved gas levels. However, spill is limited by Clean Water Act requirements. HCP signors agree to work collectively to address water quality issues.

TABLE S-4. COMPARISON OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

A	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Associated Tributaries	There is potential for incremental water quality improvements (e.g., higher dissolved oxygen, lower turbidity and sedimentation) as total maximum daily load program and other ongoing watershed restoration efforts proceed, and benefits from improved riparian protections are seen (no change from existing conditions).	Same as Alternative 1.	Same as Alternative 1, although guaranteed PUD funding would provide for more restoration projects and improvements in tributary water quality.
Columbia River System/Cumulative Effects	No change from existing conditions.	Spill programs may increase total dissolved gases in project area and at downstream hydroelectric projects.	Similar to Alternative 1, although the PUDs would work collectively to minimize total dissolved gas levels.
<u>/egetation</u>			
Project Area	No change from existing conditions.	Same as Alternative 1. If reservoir drawdown occurs, it could impact shoreline and aquatic vegetation. One threatened plant species (giant hellborine) could potentially be affected by a drawdown and may require additional ESA consultation.	Same as Alternative 2 but may also include off-site improvements in the production and carrying capacity of the mainstem Columbia River.
Associated Tributaries	Some local and State fish habitat improvement projects could improve riparian vegetation – no change from existing conditions.	Same as Alternative 1.	Same as Alternative 1, and HCP funding for tributary improvements would potentially benefit vegetation by removing invasive nonnative plant species, adding or enhancing soils, and establishing buffer areas along tributary streams.
Columbia River System/Cumulative Effects	No change from existing conditions.	Same as Alternative 1.	Same as Alternative 1.
<u> Wildlife</u>			
Threatened, Endangered, a	nd Sensitive Wildlife Species		
Project Area	No change from existing conditions.	No effect anticipated. If drawdown occurs, bald eagle abundance may decline due to declines in waterfowl prey.	Same as Alternative 2.

TABLE S-4. COMPARISON OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Į.	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Associated Tributaries	Possible short-term disturbance to bald eagles from tributary habitat improvement projects conducted by other agencies. Possible benefits to bald eagles if projects improve riparian habitat and waterfowl prey base.	Same as Alternative 1.	Same as Alternative 1. HCP funding for tributary improvements could enhance habitat.
	No effects on northern spotted owls, gray wolves, or grizzly bears.		
	No change from existing conditions.		
Columbia River System/Cumulative Effects	No effect.	Same as Alternative 1.	Same as Alternative 1.
Other Wildlife			
Project Area	Possible decline in avian predator abundance due to continued implementation of predator control programs. No effect to other wildlife. No change from existing conditions.	Same as Alternative 1. If drawdown occurs, declines in abundance of waterfowl, aquatic furbearers, amphibians, and other riparian-associated wildlife may result.	Same as Alternative 2. In addition, HCP funding for tributary improvements could enhance habitat for fish and wildlife.
Associated Tributaries	Possible short-term disturbance to wildlife from tributary habitat improvement projects conducted by other agencies. Possible benefits to waterfowl, aquatic furbearers, and other riparian associated wildlife, if projects improve riparian habitat.	Same as Alternative 1	Same effects from PUD and other agency habitat improvement projects as Alternative 1 and 2.
Columbia River System/Cumulative Effects	No effect.	Same as Alternative 1.	Same as Alternative 1.
Land Use			
Project Area	No changes from existing conditions.	May be modified if listed species are affected	The PUD will consider cumulative effects of land use decisions, accept comments on such actions from signatory parties, and no applicants of potential incidental take restrictions.
Associated Tributaries	Local and State aquatic habitat enhancement projects may alter floodplains and result in land exchanges. Less development would be allowed at river shorelines. No change from existing conditions.		Same as Alternative 1, although more actio are expected under the tributary fund.

TABLE S-4. COMPARISON OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Columbia River System/Cumulative Effects	No change from existing conditions.	Same as Alternative 1.	Same as Alternative 1.
<u>Aesthetics</u>			
Project Area	Projects viewed in rural setting.	Same as Alternative 1. Project conservation measures do not change scenic quality in the area. If drawdown occurs, substantial unvegetated barren earth would be seen in area of drawdown.	Same as Alternative 2.
Associated Tributaries	Tributaries occur in forested (higher elevation) and rural settings (lower elevations).	Same as Alternative 1.	Same as Alternative 1.
Columbia River System Cumulative Effects	Projects appear as man-made modifications to the Columbia River.	Same as Alternative 1. No developments planned in the area change the project scenic quality.	Same as Alternative 2.
Socioeconomics			
Project Area	No changes from existing conditions.	Electricity rates will go up as a result of higher production costs and the need to replace lost energy from more expensive generating plants. The amount of increase is based on the measures imposed on the PUDs. If drawdown is proposed, a detailed socioeconomic analysis would be conducted.	Less that Alternative 2 as the PUDs have the ability to implement the lowest cost measure to achieve defined survival standards.
Associated Tributaries	Short-term local jobs under independent tributary habitat improvements. No change from existing conditions.	Same as Alternative 1.	Same as Alternative 1, and Plan Species Account will provide some additional jobs ar service-related income.
Columbia River System/Cumulative Effects	No changes from existing conditions.	Same as Alternative 1.	Same as Alternative 1.
Economics			
Project Area	No change from existing conditions.		
Associated Tributaries	Not applicable.		
Columbia River System/Cumulative Effects	Not applicable.		

TABLE S-4. COMPARISON OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

A	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Recreation			
Facility Operation and Maintenance	No changes from existing conditions.	Same as Alternative 1. If drawdown occurs, reduced pool levels would make boat ramps and beaches unusable and substantially impact recreational facilities.	Same as Alternative 2.
Associated Tributaries	Short-term access may be affected as local and State aquatic habitat improvements occur through independent WRIA actions. No change from existing conditions.	Same as Alternative 1.	Same as Alternative 1, although the additional PUD-funded habitat improvements could affect short-term access.
Columbia River System/Cumulative Effects	No changes from existing conditions.	Same as Alternative 1. If drawdown occurs, increased fishing upstream and downstream of the projects may result.	Same as Alternative 2.
Cultural Resources			
Project Area	No change from existing conditions.	Same as Alternative 1. If drawdown occurs, substantial impacts could occur to cultural resources.	Same as Alternative 2.
Associated Tributaries	Tributary habitat improvements that occur through independent actions could affect some cultural resources unless surveys and mitigation (if needed) are conducted prior to earth moving activities. However, regulatory compliance with applicable laws is expected.	Same as Alternative 1.	Same as Alternative 1, although additional PUD-funded habitat improvements would be expected.
Columbia River System/Cumulative Effects	No change from existing conditions.	No change would occur. If drawdown occurs, impacts could occur to cultural resources at downstream dams.	Same as Alternative 2.

ESA = Endangered Species Act









Public Utility District No. 1 of Chelan County

Anadromous Fish Agreements and Habitat Conservation Plans for the Wells, Rocky Reach, and Rock Island Hydroelectric Projects

Final Environmental Impact Statement

Submitted pursuant to the National Environmental Policy Act [42 U.S.C. 4322(2)(c)]

by the

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NATIONAL MARINE FISHERIES SERVICE

in cooperation with

PUBLIC UTILITY DISTRICT NO. 1 OF DOUGLAS COUNTY PUBLIC UTILITY DISTRICT NO. 1 OF CHELAN COUNTY FEDERAL ENERGY REGULATORY COMMISSION

ACRONYMS

ALCOA Aluminum Company of America

BIA Bureau of Indian Affairs
BLM Bureau of Land Management

BOR Bureau of Reclamation

BP before present

BPA Bonneville Power Administration
CEQ Council on Environmental Quality
CFR Code of Federal Regulations

cfs cubic feet per second

DDT dicholoro-diphenyl-tricholoroethane Ecology Washington Department of Ecology EIS Environmental Impact Statement

FERC Federal Energy Regulatory Commission

HCP habitat conservation plan

JARPA Joint Aquatic Resource Permit Application

kcfs thousand cubic feet per second NEPA National Environmental Policy Act NMFS National Marine Fisheries Service

NTU nephelometric turbidity unit

ODFW Oregon Department of Fish & Wildlife

PIT passive integrated transponder

PUD public utility district

QAR Quantitative Analysis Report RCW Regulatory Code of Washington

ROD Record of Decision

SEPA State Environmental Policy Act TMDL total maximum daily load

USC United States Code

USDA U.S. Department of Agriculture USDOE U.S. Department of Energy

USEPA U.S. Environmental Protection Agency

USFS U.S. Forest Service

USFWS U.S. Fish & Wildlife Service USGS U.S. Geological Survey

WAC Washington Administrative Code

WDFW Washington Department of Fish & Wildlife

WRIA Watershed Resource Inventory Area

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Final Environmental Impact Statement

Anadromous Fish Agreements and Habitat Conservation Plans for the Wells, Rocky Reach, and Rock Island Hydroelectric Projects

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Abstract: The U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS) is evaluating the decision to authorize incidental take permits pursuant to Endangered Species Act Section 10(a)(1)(B) for 50-year anadromous fish agreements and habitat conservation plans (HCPs) with two Washington State public utility districts (PUDs [Chelan County PUD and Douglas County PUD]). The HCPs were developed to protect five species of Columbia River steelhead and salmon (spring-run chinook salmon [Oncorhynchus tshawytscha], summer/fall-run chinook salmon [O. tshawytscha], sockeye salmon [O. nerka], steelhead [O. mykiss], and coho salmon [O. kisutch]), two of which are currently listed as endangered (Upper Columbia River spring-run chinook salmon and steelhead) under the Endangered Species Act. The HCPs' fish protection measures also satisfy the PUDs' regulatory obligations with respect to anadromous salmonid species under the Federal Power Act, Fish and Wildlife Coordination Act, Pacific Northwest Electric Power Planning and Conservation Act, and Title 77 RCW. The agreements would set a "no net impact" standard for salmon and steelhead protection at three hydropower projects (Wells, Rocky Reach, and Rock Island) operated by the Chelan and Douglas County PUDs, and provide the PUDs with some degree of certainty for the long-term operation of these projects. Plan coverage of the three species not listed as endangered should help prevent the need to list these species in the future. This EIS describes three alternatives. Alternative 1 is the no-action alternative that represents existing conditions under the project licenses, subsequent license amendments, and settlement agreements. Alternative 2 is application of alternative anadromous fish conservation measures considered during the NEPA process that could be implemented under the Federal Power Act or Section 7 of the Endangered Species Act, whereas Alternative 3 represents application of the measures and survival standards defined in the HCP. Under Alternative 3, three HCPs representing Wells, Rocky Reach, and Rock Island hydroelectric projects would be approved and in effect over a 50year permit term.

The following table summarizes the expected conservation measures associated with each alternative, relative to the components of the no net impact standard established for Alternative 3. This standard consists of meeting 91 percent combined adult and juvenile project passage survival, with compensation for the remaining 9 percent unavoidable

project passage mortality through 7 percent hatchery production and 2 percent funding of tributary habitat enhancement projects.

EXPECTED CONSERVATION MEASURES BY ALTERNATIVE

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
ESA-Listed Anadromous Salmonid Protection	No additional protection for ESA-listed anadromous salmonid species	Additional protection necessary to prevent extinction of the ESA-listed anadromous salmonid species	Additional protection to meet a no net impact standard consisting of 91% combined adult and juvenile survival, habitat improvements, and hatchery production
Non-Listed Anadromous Salmonid Protection	No additional protection	No additional protection	Same as above for ESA-listed anadromous salmonid species
ESA-Listed Species Recovery Potential	Steelhead and spring-run chinook populations continue trending down at a loss rate of 5 to 10% per year	Estimated 22 to 45% survival improvement potential over Alternative 1; additional basin-wide measures needed to meet recovery goals	Similar to Alternative 2, plus up to an additional 6% survival increase due to tributary habitat enhancements; additional measures may be needed to meet recovery goals
Juvenile Survival Standard	Meet existing on-site fish passage efficiency criteria	Increase spill, as needed, to meet unspecified survival rates for ESA-listed species	Meet the juvenile component of the no net impact standard (93% juvenile project passage, or 95% juvenile dam passage survival) for all anadromous salmonids
Adult Survival Standard	Continue existing fish passage protocols	Minimize impacts to ESA-listed species	Meet the adult no net impact standard component (98% project passage survival) for all anadromous salmonids
Tributary Habitat Enhancement	No PUD-funded habitat improvements	Same as Alternative 1	\$46.5 million (1998 dollars) PUD funding provided over 50 years
Hatchery Production	Meet existing license and settlement criteria	Same as Alternative 1, although likely reductions to minimize effects on ESA- listed species	Same as Alternative 1 until at least 2013; possible subsequent reductions based on impacts to ESA-listed species
Cost	\$156 for Wells	\$867 for Wells	\$188 for Wells
(in millions)	\$392 for Rocky Reach	\$1,474 for Rocky Reach	\$511 for Rocky Reach
	\$170 for Rock Island	\$688 for Rock Island	\$316 for Rock Island

ESA = Endangered Species Act

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CHANGES MADE BETWEEN THE DEIS AND FEIS FOR CHAPTER 1

- Changes in Chapter 1 were made to address public comments on the Draft EIS and to describe in greater detail NMFS's NEPA approach and analysis for this project.
- Redundancies within and between Chapters 1 and 2 were eliminated. For example, a description of the proposed alternatives was presented in Chapters 1 and 2 of the DEIS, but is now presented in its entirety in Chapter 2.
- Key Terms includes a definition of the Quantitative Analysis Report (QAR).
- An explanation of why bull trout are addressed in the EIS is included.
- Chapter 1 further describes the goal of the HCPs and incidental take permits for the three hydroelectric projects.
- Chapter 1 provides greater detail of PUD options for complying with the Endangered Species Act.
- Chapter 1 has a description of completed interim Section 7 consultations.
- A new section under Federal Requirements describes requirements of the Magnuson-Stevens Fishery Conservation and Management Act and the definition of Essential Fish Habitat as applied to the Mid-Columbia River reach
- Chapter 1 clarifies the position of the Tribes regarding 7 percent hatchery compensation levels.
- A description of a recent U.S. District Court decision that vacated the critical habitat designations for 19
 Evolutionarily Significant Units for Upper Columbia River steelhead and spring-run chinook salmon is
 included.
- The energy production levels of the three projects are provided.
- Previous and ongoing management programs in the Plan area are expanded and clarified.
- An overview of the DEIS public review process and negotiated HCP revisions is included.
- Minor word corrections, definitions, and recent references are included where pertinent in Chapter 1.
- The Background Summary section was removed to reduce redundancy within Chapter 1.

Chapter

1

PURPOSE AND NEED FOR ACTION

Key Terms *

- **Adaptive management** The process of monitoring the implementation of conservation measures, then adjusting future conservation measures according to what was learned. Adaptive management can also include testing of alternative conservation measures, monitoring the results, and then choosing the most effective and efficient measures for long-term implementation.
- **Biological assessment** A requirement under the Endangered Species Act of 1973 to assess the effects of a Federal action on a Federally listed threatened or endangered species. A biological assessment report is prepared by the project proponent and provides existing and projected conditions that affect a threatened or endangered species and the proposed mitigation measures that minimize or avoid impacts to these species.
- **Biological opinion** An opinion from the U.S. Fish and Wildlife Service or the National Marine Fisheries Service as to the effects of a Federal action on a Federally listed threatened or endangered species. The biological opinion is a report that reviews and considers the adequacy of the biological assessment that is initially prepared by the project proponent. The biological opinion includes conservation measures recommended by the agency to protect the listed species.
- **Endangered Species Act** The Endangered Species Act of 1973, 16 USC §§ 1531 through 1543, as amended and its implementing regulations. Federal legislation that provides a means to ensure the continued existence of threatened or endangered species and the protection of critical habitat of such species.
- Habitat Conservation Plan (HCP) Under Section 10(a)(2)(A) of the Endangered Species Act, a planning document that is a mandatory component of an incidental take permit application. The HCP process is intended to provide a comprehensive, long-term management plan to protect and facilitate the recovery of threatened and endangered species, and to provide a framework for "creative partnerships" between the public and private sectors in endangered species conservation (H.R. Rep. No. 97-835, 97th Congress, Second Session). The term HCP in this EIS also refers to the "Anadromous Fish Agreement and Habitat Conservation Plans," conditional agreements for each of the three projects to implement an HCP; these HCPs also serve as settlement agreements to be filed with FERC.
- Incidental take permit A permit that exempts a permittee from the take prohibition of Section 9 of the Endangered Species Act provided that a "conservation plan" has been developed that specifies the likely take and steps that the applicant will use to mitigate and minimize the take. An incidental take permit is issued by USFWS or NMFS or both under Section 10 of the Endangered Species Act for non-Federal applicants.
- Incidental take statement An incidental take statement is issued under Section 7 of the Endangered Species Act for projects that involve a Federal action. The statement identifies the extent of the take that would occur as a result of the action, as well as reasonable and prudent measures to minimize the take.
- No Surprises policy A policy of NMFS and USFWS providing regulatory assurances to an HCP incidental take permit holder that no additional land use restrictions or financial compensation would be required with respect to species covered by the applicant's incidental take permit, even if unforeseen circumstances arise after the permit is issued that indicate additional mitigation is needed to protect the species (50 CFR § 222.303[g]).
- Quantitative Analysis Report (QAR) The Upper Columbia QAR process was established to provide decision makers with current assessments of the status of Endangered Species Act-listed spring-run chinook salmon and steelhead runs returning to the Upper Columbia River. Simple population models were developed for Upper Columbia River spring-run chinook salmon (Wenatchee, Entiat, and Methow populations) and summer steelhead (Wenatchee/Entiat and Methow populations). The models are based on reconstructed spawner to spawner return ratios for historical years. Alternative assumptions regarding the effectiveness of hatchery-origin spawners are also considered in the analyses. A range of alternative future survival improvements for Upper Columbia River stocks were modeled, including an analysis of the expected survival improvements that could be expected from implementation of the long-term mitigation measures outlined in the Chelan and Douglas County PUD HCPs.
- * See Chapter 7 for a complete listing of all Key Terms.

1.1 Introduction

The U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS) is evaluating the decision to authorize incidental take permits, in accordance with Section 10 (a)(1)(B) of the Endangered Species Act of 1973, for 50-year anadromous fish agreements and habitat conservation plans (HCPs) with two Washington State public utility districts (PUDs) for the Wells (Federal Energy Regulatory Commission [FERC] project number 2149), Rocky Reach (FERC project number 2145), and Rock Island (FERC project number 943) hydroelectric projects (67 Federal Register 42755 [June 25, 2002]). The HCPs were developed to protect five species of Columbia River anadromous salmonids (referred to as Plan species), two of which are currently listed as endangered under the Endangered Species Act.

The fish protection measures and methodologies proposed under the HCPs would also represent long-term settlement agreements under the Federal Power Act, Fish and Wildlife Coordination Act, Pacific Northwest Electric Power Planning and Conservation Act, Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act, and Title 77 Regulatory Code of Washington (RCW) for the five species.

The HCPs are consistent with the protocols and provision of the Basinwide Salmon Recovery Strategy "All-H Paper" (Federal Caucus 2000) and the reasonable and prudent alternatives contained in the biological opinion for the Federal Columbia River Power System (NMFS 2000a).

The agreements would set a "no net impact" standard for salmon and steelhead protection at three hydropower projects operated by the Chelan and Douglas County PUDs and provide the PUDs with some degree of certainty for the long-term operation of these projects. Plan coverage of the

three species not listed as endangered is expected to reduce the possibility that these species would be listed in the future.

The anadromous fish agreements and HCPs are the result of more than 9 years of planning and negotiations between the interested parties. In addition to NMFS and the PUDs, participants in the HCP development process were the U.S. Fish and Wildlife Service (USFWS), Washington Department of Fish and Wildlife (WDFW), the Confederated Tribes and Bands of the Yakama Indian Nation (Yakama), the Confederated Tribes of the Colville Reservation (Colville), and the Confederated Tribes of the Umatilla Indian Reservation (Umatilla) (collectively, the Joint Fisheries Parties); American Rivers, Inc.; and the major wholesale purchasers of the PUDs' electricity.

NMFS is the Federal agency responsible for protecting anadromous salmon and steelhead and is the lead agency for this National Environmental Policy Act (NEPA) final environmental impact statement (FEIS). The FERC is a cooperating agency for the purpose of developing the EIS, and the PUDs will coordinate compliance with the State Environmental Policy Act (SEPA).

The PUD No. 1 of Douglas County is applying for a permit covering the Wells Hydroelectric Project, and the PUD No. 1 of Chelan County is applying for permits to cover the Rocky Reach and Rock Island hydroelectric projects. The permit applications are based upon the HCPs and their exhibits and supporting documents.

The incidental take permits would provide coverage for four Permit species:

1. Upper Columbia River spring-run chinook salmon (*Oncorhynchus tshawytscha*),

- 2. Upper Columbia River summer/fall chinook salmon (*O. tshawytscha*),
- 3. Okanogan River and Lake Wenatchee sockeye salmon (*O. nerka*), and
- 4. Upper Columbia River steelhead (*O. mykiss*).

Currently, Upper Columbia River steelhead and spring-run chinook salmon are listed as endangered under the Endangered Species Act. During the species status evaluations, NMFS and USFWS determined that these Evolutionarily Significant Units represented the last of the remaining genetic resources of fish that migrated into the Upper Columbia River prior to the construction of Grand Coulee Dam. As a result, although these fish spawn in an area typically referred to as the Mid-Columbia River reach, they are designated as Upper Columbia River Evolutionarily Significant Units. For the purpose of this EIS, the Mid-Columbia River Reach is defined as the area of the river between the Chief Joseph Dam tailrace and the confluence of the Yakima River.

Although summer/fall chinook and sockeye salmon have not been listed, the Permits would cover these species as well, according to the June 17, 1999 Federal policy governing the use of HCPs for the conservation of candidate or

potential candidate species. The "No Surprises" policy associated with these agreements assures the PUDs that no additional measures would be required by NMFS for the duration of the Permits, for any of the Permit species.

Coho salmon (O. kisutch), an extinct species in the Mid-Columbia region, are also included in the HCPs as a Plan species. Recently, attempts have been made to reintroduce coho salmon into the area.

Although a Plan species, coho salmon are not considered a Permit species because an extinct species is not subject to Endangered Species Act jurisdiction. Thus, there are four Permit species and five Plan species covered by the HCP agreements.

The Columbia River bull trout populations were also listed as threatened under the Endangered Species Act in June 1998 (USFWS 1998). Because bull trout are not an anadromous species, this species is under the jurisdiction of the USFWS, rather than NMFS. The HCPs cover anadromous species under the jurisdiction of NMFS. However, bull trout are reviewed in this EIS to ensure that the HCPs' conservation measures do not negatively affect bull trout migration, breeding, cover, and resting areas.

1.2 PROJECT APPLICANTS

The project proponents are the following:

- The Douglas County PUD, a Washington municipal corporation, is sponsoring the Wells Anadromous Fish Agreement and HCP.
- The Chelan County PUD, a Washington municipal corporation, is sponsoring the Rocky Reach and Rock Island Anadromous Fish Agreements and HCPs.

The Chelan and Douglas County PUDs would file applications requesting FERC to amend their existing licenses to include the HCPs. In addition, the PUDs would rely upon the HCPs to fulfill their obligations for anadromous salmonids under new license agreements.

The HCPs would meet the Endangered Species Act requirements for the Permit species through the 50-year HCP terms. The Wells HCP becomes effective on the date that FERC adopts the HCP terms into the project license. The Rocky Reach and Rock Island HCPs would become effective

on the date the last signatory party signs the agreements. If FERC does not relicense the projects, or issues a license inconsistent with the conditions of the Permit and HCP, then NMFS

may withdraw from the agreement and the Permit will not take effect. The applicants would then be obligated to meet Endangered Species Act requirements through Section 7 consultations.

1.3 PURPOSE AND NEED

The purpose and need for this project is to develop methods to protect anadromous salmonids in the Mid-Columbia River reach while allowing Chelan and Douglas County PUDs to continue to generate electricity to meet the power demands of the Pacific Northwest. The action alternatives considered in this EIS would result in:

- developing a comprehensive, long-term strategy for protecting and aiding in the recovery of anadromous salmonids in the Mid-Columbia River, two of which are currently listed as endangered under the Endangered Species Act;
- providing a process for managing fish passage issues for relicensing the three projects under the Federal Power Act;
- meeting applicable legislative requirements pertinent to the Endangered Species Act, including ensuring that any incidental take of listed species caused by the projects would not appreciably reduce the likelihood of the survival and recovery of the species it the wild;
- meeting NMFS's responsibilities under the Magnuson-Stevens Fishery Conservation Act to ensure the sustainability of the nation's fisheries resources;
- allowing the Chelan and Douglas County PUDs to plan for long-range operations with a degree of certainty to economically operate their projects and fulfill their long-term bonding and contractual sales obligations; and

 helping to ensure stable power supplies and pricing for the utilities' customers.

The project need is based on the substantial population decline of anadromous salmonids since European settlement of the Columbia River Basin. This decline is due (1) loss, destruction, or degradation of tributary habitat; (2) overharvest, genetic introgression, and competition with hatchery-reared fish; and (3) habitat inundation, blockage, and mortality from construction and operation of dams and reservoirs. Increased survival of all life stages of anadromous fish within the Columbia River Basin is necessary to meet the dual goals of recovering Endangered Species Act-listed anadromous fish and providing self-sustaining, harvestable populations of anadromous salmonids. The Wells, Rocky Reach, and Rock Island hydroelectric projects have affected anadromous salmonid populations through inundation of mainstem spawning and rearing habitat, decreased survival of migrating juveniles as they pass the projects, and possibly by decreasing survival or spawning success of migrating adults.

Since the projects were constructed, the applicants have worked (often in cooperation with other resource managers) to improve fish passage survival through facility and operational improvements and mitigate for project effects by funding hatcheries. Under the current licenses and agreements, each of the three projects has unique mitigation, compensation, and species protection requirements. However, a coordinated, comprehensive approach with similar performance survival standards among the three dams is currently not in place. Because the projects occur in the same geographical area (whereby the reservoirs of the downstream

projects encroach on the tailraces of the upstream projects) and operationally affect each other through changes in water quality parameters, a comprehensive cooperative approach among the projects would help to minimize fish losses and enhance fish passage opportunities in the Mid-Columbia reach.

1.4 PROJECT LOCATION

The Wells, Rocky Reach, and Rock Island hydropower projects are part of an 11-dam system on the mainstem Columbia River within the continental United States. Their location relative to the other projects in the region is shown in Figure 1-1. Most of the projects on the mainstem Columbia River are Federally operated, although local PUDs operate five of the projects in the Mid-Columbia River segment. In addition to the three projects operated by the Chelan and Douglas County PUDs, the PUD No. 2 of Grant County operates the Priest Rapids and Wanapum dams (Priest Rapids Project).

The Douglas County PUD operates the Wells Project located at river mile 515.8 on the Columbia River, north of the City of Wenatchee (Figure 1-2). Wells began commercial operations on August 22, 1967, and is operated under a license issued by FERC, which expires in the year 2012.

Chelan County PUD operates the Rocky Reach and Rock Island hydroelectric projects. Rocky Reach Dam is located about 7 miles upstream from the City of Wenatchee, at river mile 473.7 (Figure 1-2). The Federal Power Commission issued the original operating license for Rocky Reach on July 11, 1957. The license expires in 2006. Rock Island, which was the first hydroelectric project to span the Columbia River, is located about 13 miles downstream from the City of Wenatchee at river mile 453.4 (Figure 1-

2). Rock Island began operating in 1933, and its operating license expires in the year 2028.

The project boundaries include the forebay (from the dam to approximately 500 feet upstream), tailrace (from the dam to approximately 1,000 feet downstream), and reservoir associated with each dam. The Wells reservoir extends approximately 30 miles upstream of the dam to the Chief Joseph Dam tailrace, the Rocky Reach reservoir extends approximately 41 miles upstream of the dam to the Wells tailrace, and the Rock Island reservoir extends approximately 20 miles upstream of the dam to the Rocky Reach tailrace. Considering all components of the three projects, the entire project area extends from the tailrace of the Rock Island Dam upstream to the tailrace of Chief Joseph Dam (approximately 92 miles) (Figure 1-2). Some project effects, however, continue downstream through the Hanford Reach to the confluence of the Yakima River (inclusively defined as the action area). Project effects that continue downstream include water quality impacts (e.g., total dissolved gas levels) and delayed mortality of fish passing the projects.

All three of the hydroelectric projects discussed in this EIS are "run-of-the-river" facilities, which means that they have limited storage capacity compared to larger reservoir projects, such as Grand Coulee and Chief Joseph dams.

1.5 REGULATORY FRAMEWORK

The utilities are acting within a complex regulatory framework, particularly at the Federal level. This EIS has been prepared by NMFS, which is responsible for protecting anadromous fish under the Endangered Species Act, in cooperation with FERC, which is responsible for licensing the hydroelectric projects. The EIS is being made available to the public as required by

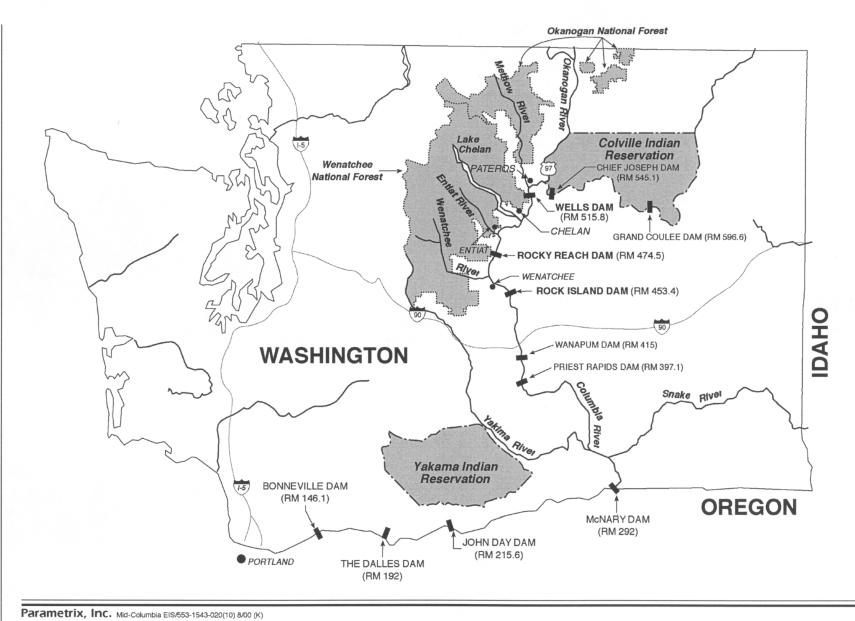
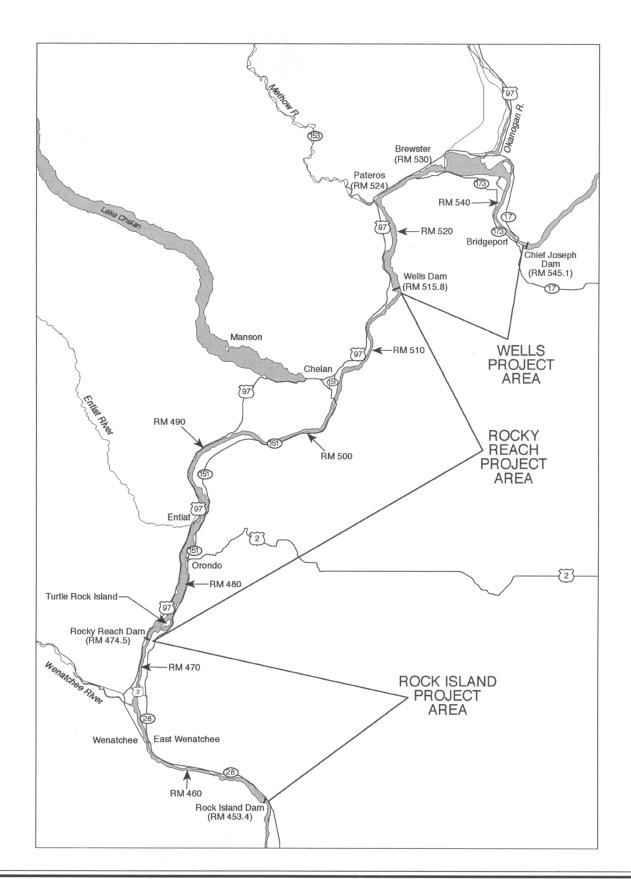




Figure 1-1 General Location of Columbia River Dams



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Figure 1-2 Project Area NEPA, as amended (42 USC 4321 et seq.), NEPA regulations (40 CFR 1500-1508), NMFS policies and procedures for implementing NEPA, and following NOAA's Administrative Order 216-6, Environmental Review Procedures for Implementing the National Environmental Policy Act.

1.5.1 APPLICANT'S REGULATORY FRAMEWORK FOR COMPLIANCE WITH ENVIRONMENTAL LAWS

The hydroelectric projects included under the HCPs are owned and operated by Chelan and Douglas County PUDs and are licensed by FERC according to the Federal Power Act. Their existing licenses include requirements and restrictions related to how the projects are maintained and operated. The utilities are also required to comply with other State and Federal regulations for environmental protection and for planning and financing their long-range capital improvements.

1.5.2 OVERVIEW OF FEDERAL REQUIREMENTS FOR SPECIES CONSERVATION

The Endangered Species Act of 1973 requires the protection of threatened and endangered species and promotes their recovery. NMFS and USFWS share joint authority under the Endangered Species Act for species protection. USFWS is responsible for terrestrial and freshwater aquatic species, and NMFS is responsible for species in marine environments (mammals, anadromous fish, and other living marine resources). Anadromous salmonids spend the majority of their life cycle in the marine environment. Thus, NMFS is the responsible agency for their protection under the Endangered Species Act.

Section 9 of the Endangered Species Act prohibits the taking of an endangered species. Take is defined under the Endangered Species Act to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect." Harm has

been further defined by NMFS to include "significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, feeding, and sheltering." NMFS (or USFWS) may issue permits, under limited circumstances, to allow the take of listed species incidental to otherwise lawful activities. These incidental take permits are issued for non-Federal actions under Section 10(a)(1)(B) of the Endangered Species Act. Similarly, incidental take statements are issued for Federal actions under Section 7(a)(2) of the Endangered Species Act. The NMFS implementing regulations governing threatened and endangered species are detailed in 50 CFR 222.307.

The PUDs have the option of requesting authorization for incidental take of Endangered Species Act-listed species voluntarily through the Section 10 process or relying on FERC (as the licensing entity for the dams) to consult with NMFS regarding project compliance through the Section 7 process. For the latter case, in order for the incidental take associated with the operation of the projects to be authorized by NMFS, FERC would need to adopt the requirements from an incidental take statement issued by NMFS during Section 7 consultation with FERC into the PUD's licenses.

In the former case, the PUDs consult directly with NMFS regarding Section 10 implementation and compliance, although FERC would also be required to consult with NMFS pursuant to Section 7 at the time the licenses are amended to include the HCPs. However, in this instance, NMFS assumes that FERC's proposed action (license amendment) would be identical to NMFS's proposed action (issuance of a Section 10 permit), and that the findings of the subsequent biological opinions would also be identical. The PUDs have the option to pursue the Section 10 permitting process because the dams are owned and operated by the PUDs.

1.5.2.1 Endangered Species Act Requirements for Non-Federal Actions

Under the HCPs, the PUDs (which are non-Federal applicants) would obtain incidental take permits under Section 10(a)(1)(B) of the Endangered Species Act. The HCPs identify the likely impacts of the take and specify the mitigation and minimization steps the applicants would take to protect species that are listed under the Endangered Species Act. For a permit to be issued, Federal regulations specify that an HCP must meet the following requirements:

- The taking will be incidental to an otherwise lawful activity.
- The applicant will, to the maximum extent practicable, minimize and mitigate the impact of such taking.
- The applicant will ensure adequate funding for the plan.
- The taking will not appreciably reduce the likelihood of survival and recovery of the species in the wild.
- The applicant will implement other necessary and appropriate measures to the plan, as determined by NMFS at the time of permitting.

If a conservation plan meets these criteria and is approved, the Permits are valid for a specified term (50 years in these HCPs), as long as the applicant complies with the terms and conditions of the Permit. See Section 2.3.4.2, HCP Term for more detailed information on term conditions and provisions. No additional measures or conditions can be required, except as provided for in the HCPs and the No Surprises policy.

The No Surprises Policy{ XE "Report sections:The No Surprises Policy" }

Endangered Species Act regulations originally allowed NMFS and USFWS to add mitigation measures after a Section 10 permit was issued if "unforeseen circumstances" occurred, such as if the species continued to decline. This provided more flexibility to protect resources, but resulted in uncertainty for the permit holders. To address this uncertainty, President Clinton's administration developed the No Surprises policy in 1994, and the policy became a regulation in 1998 (50 CFR part 222). The No Surprises policy means that, as long as an HCP is being properly implemented, the Section 10 permit is valid, and nothing more can be required. Typically, even if the status of the species protected by an HCP unexpectedly worsens, the permit holder's costs for conservation and mitigation will remain as agreed. However, in the case of these HCPs, in certain circumstances, NMFS may withdraw from the HCP agreement and revoke the Permits to seek additional species conservation measures.

Adaptive Management

The Wells, Rocky Reach, and Rock Island HCPs, like other recently developed HCPs, incorporate an adaptive management approach that helps to assure that additional protection measures can be implemented over time as information is developed. The adaptive management approach is described in HCP Section 10.2 (Endangered Species Act Permit Monitoring) and Section 12.7 (Force Majeure) for the three projects, as well as Section 10.3.2 (Endangered Species Act Permit Modification) in the Rocky Reach and Rock Island HCPs. An HCP must include measurable biological goals and objectives, negotiated during HCP development, that remain in place during the term of the HCP. These goals are described in Section 3 of the HCPs (Survival Standards and Allocation of Responsibility for No Net Impact). The adaptive management approach allows the

applicants, agencies, and other interested parties to work cooperatively during HCP implementation and determine alternative strategies to meet the HCP goals when the initially adopted strategies do not successfully meet the objectives. An adaptive management approach would involve research and monitoring throughout the term of the HCP, and using what is learned to adjust conservation management actions. This adaptive management approach is would be implemented under the guidance of the HCP coordinating committees.

Adaptive management is an essential element of HCPs that cover large areas or regions where a significant degree of biological uncertainty exists. When there are many unknown factors about a species in a Plan area, the risk to the species increases, and a more intensive adaptive management approach is needed. The approach would involve more research and monitoring, with assessment milestones at frequent intervals. The HCPs include progress reporting, reviews, and evaluation to ensure that HCP goals are being achieved (see Wells HCP Sections 6.8 and 6.9 [Coordinating Committee Studies and Reports and Progress Reports] and Rocky Reach and Rock Island HCP Sections 4.8 and 4.9 [Coordinating Committee Studies and Reports and Progress Reports]). The Departments of the Interior and Commerce have recently drafted guidelines on adaptive management to make the approach a standard part of the HCP and incidental take permitting process (64 Fed. Reg. 45 [March 9, 1999]).

1.5.2.2 Endangered Species Act Requirements for Federal Actions

The Endangered Species Act Section 7(a)(2) requires Federal agencies to consult with NMFS (for certain species) to ensure that any agency action is not likely to jeopardize the continued existence of any endangered or threatened species or result in the adverse modification of designated critical habitat of such species. Fish protection

measures would be implemented through relicensing and license amendment or license reopener proceedings. In either case, FERC's action on the license would likely trigger an obligation to consult with NMFS and USFWS pursuant to Section 7(a)(2). Whenever FERC is considering an action that may have an adverse effect on a listed species, it must consult with NMFS or the USFWS (FERC was recently involved in this process relative to the PUDs applications for approval of interim protection plans for the listed species).

These consultations were intended to cover the projects' operations until a decision is made on whether to approve the HCPs. Section 7 consultation has been completed for the interim protection plan for the operation of the Wells Project (NMFS 2000b); however, the term of this consultation expired in April 2002, and FERC has given no indication that it intends to reinitiate consultation. Section 7 consultation has also recently been completed for the construction and operation of a juvenile fish bypass system at Rocky Reach Dam, as well as the continued operation of the project through the term of its existing FERC license (2006) (NMFS 2002a).

The terms and conditions under the Section 7 process can be very similar to those under the Section 10 (non-Federal) process. Under Section 7, the Federal agencies must reinitiate their consultations if new information becomes available, and new terms and conditions can be required. The proposed HCPs utilize an adaptive management approach that includes study requirements, performance standards, and a process for determining and implementing additional protective measures (if necessary). The HCPs also allow NMFS to withdraw from the agreement, revoke the Permit, and seek additional protection in certain circumstances. FERC consultation responsibilities are broad under Endangered Species Act Section 7(a)(1), but limited to proposed Federal actions (not licensee actions) in Section 7(a)(2).

1.5.2.3 NMFS Regulatory Requirements

NMFS, as part of its responsibilities under the Endangered Species Act, is responsible for determining whether to list a species as threatened or endangered, designating critical habitat for listed species, determining whether proposed actions will likely jeopardize the continued existence of a listed species or adversely modify their designated critical habitat, authorizing incidental take in certain circumstances, and developing species recovery plans. NMFS is also subject to the requirements of NEPA and to a substantial number of other Federal regulations, policies, and orders.

Section 9 of the Endangered Species Act states that it is unlawful to take a listed species. However, if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity, the taking may be permitted through meeting other requirements of the Act, which may include Section 7 (Federal actions) or Section 10 (non-Federal actions).

With the listing of Upper Columbia River springrun chinook salmon and steelhead as endangered, NMFS is charged with helping to implement recovery plans that (1) assess the factors affecting the species, (2) identify recovery goals, (3) identify actions needed to achieve the goals, and (4) estimate the cost and time to achieve the goals. Currently, NMFS's policy is to allow these plans to be developed through cooperative efforts with local, regional, and State governments, organizations, Tribes, and other parties. However, if a species continues to decline, NMFS has the authority to mandate recovery actions.

Through the development of this EIS, NMFS is fulfilling a key part of its regulatory requirements under NEPA for this proposed action. However, as the responsible agency for protecting anadromous salmonids under the Endangered Species Act, the agency has additional regulatory duties to perform before issuing an incidental take permit.

After the EIS is complete, to assist in determining whether the HCPs satisfy the requirements of Endangered Species Act Section 10(a)(2)(B)(iv), NMFS will prepare a biological opinion specifically to determine whether the taking authorized by the Permits appreciably reduces the likelihood of survival and recovery of the species in the wild. To issue a permit, NMFS must also find that the Permit activity will result in taking that is incidental; that the applicants will, to the maximum extent practicable, minimize and mitigate the impacts of such taking; and that the applicant has ensured that adequate funding for the plan will be provided.

1.5.2.4 FERC Regulatory Requirements

The Federal Power Act provides FERC with the exclusive authority to license non-Federal water power projects on navigable waterways and Federal lands. Sections 4(e) and 10(a)(1) of the Federal Power Act provide guidance to FERC in licensing projects that allow a wide range of uses of the waterways. Section 18 of this act allows the Services to make mandatory fishway prescriptions, and Section 10 (j) allows the Services to make recommendations for protection of fish and wildlife resources. Consequently, the Federal Power Act provides a unique vehicle for achieving fishery management and species recovery goals.

For each project, FERC will decide (1) whether to issue the license to an applicant, and (2) the conditions that should be placed on the license to protect or enhance existing environmental resources; this includes mitigation for adverse environmental impacts that would occur due to the operation and maintenance of the project.

FERC determines whether a hydropower project should be developed, and if developed, under what conditions it should be operated. Before issuing a license, FERC determines if a proposed project is "best adapted to a comprehensive plan for improving or developing a waterway or waterways" for beneficial public uses (16 USC)

§ 803[a]). FERC also considers the project's consistency with Federal or State comprehensive plans for improving, developing, or conserving the waterway.

FERC weighs competing interests, including both power and non-power uses, to ensure a proper balance. The FERC licenses include engineering, safety, economic, and environmental requirements that must be met to keep the license in effect. For example, a license can include requirements for water quality monitoring, wildlife habitat creation, a public safety plan, and erosion control plans. As part of its licensing responsibilities, FERC monitors the licensed projects to ensure compliance with its license.

Recently, FERC established an alternative administrative process to allow applicants to modify the timing of some steps of the licensing process (18 CFR parts 4 and 375; FERC, Order No. 5961 [Final Rule], October 29, 1999). The primary change involves pre-filing consultations and environmental review, which can now be combined, and are designed to improve communication and coordination between the applicant, various Federal agencies, and other parties. The alternative process also allows for the NEPA process to begin with the pre-filing stage for license applicants. Under this alternate process, the licensee would ask FERC to incorporate the HCPs as license articles into the new license.

FERC does not operate projects licensed under the Federal Power Act but is responsible for requiring that the licensees comply with their license. Proceedings to reopen existing licenses are subject to notice and hearing, other Federal Power Act protections, the terms of the license, which may reserve FERC's authority to reopen the license, notwithstanding the limitations of Federal Power Act, Section 6. FERC's consultation responsibilities under the Endangered Species Act are described in Sections 7 (a)(1) and (2) of the Endangered Species Act. The incidental take permits issued by NMFS for the three projects would allow the PUDs to operate the projects following fish protection measures described in the HCPs. These measures would supercede any existing settlement agreements pertaining to the Plan species. If approved by FERC, the HCPs would be added to the existing licenses by amendment. The parties that sign the HCPs would also propose that FERC include the HCP provisions in any new license issued during the 50-year term of the Permits.

The HCPs would address the PUDs' obligation to adequately and equitably conserve and protect Plan species and mitigate any actions that might harm the Plan species pursuant to the Endangered Species Act, Federal Power Act, the Fish and Wildlife Coordination Act, the Pacific Northwest Electric Power Planning and Conservation Act, and the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Acts as those Plan species are affected by the projects through the term of the Permits. In addition, WDFW would not request additional protection or mitigation for Plan species under Title 77 RCW. Any modification of the HCPs' terms, approval of less than the entire Plan, or addition of terms by NMFS or FERC as a result of their regulatory reviews of the HCPs shall make the HCPs voidable at the option of any party.

Performance of the PUDs' obligations under the HCPs is contingent on obtaining all necessary regulatory approvals, including applicable Federal, State, and local permits or licenses.

1.5.2.5 Other Federal, State, and Local Requirements

Fish and Wildlife Coordination Act

Whenever the waters or channel of a stream or other body of water are proposed or authorized to be modified by a public or private agency under Federal permit or license, the agency first shall consult with the USFWS and with NMFS regarding the impoundment, diversion, or other control facility to be constructed, with a view to conserving fish and wildlife. The act's purposes are to recognize the contribution of our fish and wildlife resources to the nation, and their increasing public interest and significance, and to provide that fish and wildlife conservation receives equal consideration and is coordinated with other features of water resource development programs through planning, development, maintenance, and coordination of fish and wildlife conservation and rehabilitation.

<u>Pacific Northwest Coordination</u> <u>Agreement</u>

This agreement was originally executed in 1964, and was revised in 1997 to extend the agreement until 2024. The agreement is an important component of regional plans to maximize the Northwest's hydro resource capability. Maximization also included the development of three storage projects on the Columbia River in Canada, pursuant to the terms of the 1964 Columbia River Treaty between Canada and the United States (Treaty). These storage dams provide regulated streamflows that enable Federal and non-Federal hydroelectric projects downstream in the United States to provide additional power benefits. These agreements coordinate hydro-generation after all non-power requirements (such as fish protection) are satisfied. (Performance of the Pacific Northwest Coordination Agreements will have no effect upon implementation of any alternative in this FEIS, but implementation of any of the alternatives does affect the coordination benefits of the agreements.)

The Treaty requires the United States to deliver to Canada one-half of these downstream power benefits (known as the Canadian Entitlement). The non-Federal utilities of the region have committed to provide a portion of the share of Treaty benefits required to be delivered to

Canada. In return, the United States Government agreed to participate in the coordinated operation of the hydroelectric power system. The Federal and non-Federal allocation was the subject of a separate Record of Decision (ROD); the Canadian Entitlement Allocation Extension Agreement (CEAEA) ROD was issued on April 29, 1997 by the Bonneville Power Administration (BPA).

Northwest Power Act

The Northwest Power Act, formally known as the Pacific Northwest Electric Power Planning and Conservation Act, was enacted to address regional environmental and power production coordination and management issues in the Columbia River Basin. FERC must consider the provisions of the Northwest Power Act when licensing, relicensing, or amending the licenses for Douglas and Chelan County PUDs. The major provisions of the Northwest Power Act are to:

- (1) Form the Northwest Power Planning Council to help the region develop a strategy to meet its electrical needs at the lowest possible cost.
- (2) Make the BPA responsible for system operational planning, and for managing the regional electrical system to achieve fish protection and power system efficiency goals.
- (3) Protect and enhance existing Federal laws that provide supply preference and price advantages to co-ops and publicly owned utilities.
- (4) Establish a program (through the Northwest Power Planning Council) to protect and enhance the fisheries resources of the Columbia River and to mitigate damage already done to anadromous fish populations, with funding from BPA rate revenue.
- (5) Involve the public in planning for electric resources and fish protection. State and local

- agencies are to retain control of land use and water rights.
- (6) Instruct the Northwest Power Planning Council to provide a method for balancing environmental protection and the energy needs of the region.
- (7) Require the Northwest Power Planning Council to seek the recommendations of the region's Tribal, State, and Federal fish and wildlife agencies, and ensure that its measures are consistent with the legal rights of the region's Tribes.

<u>Clean Water Act: 401 Water Quality</u> <u>Certification</u>

Under Section 401(a)(1) of the Clean Water Act, project applicants must have a State certification to verify that their project discharges comply with the applicable provisions of the Clean Water Act, or the applicant must have a waiver of certification from the State. In Washington, the Washington Department of Ecology (Ecology) is responsible for water quality permitting issues. FERC also requires licensing applicants to apply for water quality certifications or waivers before they file their FERC license application.

<u>Magnuson-Stevens Fishery Conservation</u> and Management Act

In 1996, the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) was reauthorized and changed by amendments to emphasize the sustainability of the nation's fisheries and establish a new standard by requiring that fisheries be managed at maximum sustainable levels and that new approaches be taken in habitat conservation (Public Law 104-267). These approaches include identifying Essential Fish Habitat that includes those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting this

definition of Essential Fish Habitat, the following definitions apply:

- waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate;
- substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities;
- necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and
- spawning, breeding, feeding, or growth to maturity covers a species' full life cycle (50 CFR 600.10).

The Magnuson-Stevens Act is a national program developed for the conservation and management of the fishery resources of the United States: to prevent overfishing, rebuild overfished stocks, ensure conservation, facilitate long-term protection of Essential Fish Habitat, and realize the full potential of the nation's fish resources.

The Magnuson-Stevens Act requires Federal agencies undertaking permitting or funding activities that may adversely affect Essential Fish Habitat of Federally managed commercial fish species to consult with NMFS. Through these consultations, NMFS is required to provide Essential Fish Habitat conservation and enhancement recommendations to Federal and State agencies for actions that adversely affect Essential Fish Habitat. Adverse effect means any impact that reduces quality and/or quantity of Essential Fish Habitat, and may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey or reduction in species' reproductive capabilities), site-specific, or habitatwide impacts, including individual, cumulative, or synergistic consequences of the actions.

Pursuant to the Magnuson-Stevens Act, the Pacific Fisheries Management Council has designated Essential Fish Habitat for three species of Federally managed Pacific salmon: chinook, coho, and Puget Sound pink salmon (O. gorbuscha). Two of these commercial salmon species (chinook and coho salmon) occur or will likely occur in the Mid-Columbia River reach within the term of the Permits. The freshwater Essential Fish Habitat for these species is generally defined as all current or historically accessible streams, lakes, ponds, wetlands, and other water bodies, except for areas upstream of certain impassable barriers. Consultation over the potential effects on the Essential Fish Habitat component for these species will occur under each of the action alternatives for all three of the Mid-Columbia River hydroelectric project considered in this EIS.

Title 77 Revised Code of Washington

This State code recognizes that fish and wildlife resources are the property of the State, and that the State has the obligation of preserving, protecting, and perpetuating wildlife, fish, and their habitat. Conservation, enhancement, and proper utilization of the State's natural resources, including lands, waters, timber, fish, and game, are the responsibilities of the State. While fully respecting private property rights, all resources in the State's domain shall be managed by the State such that conservation, enhancement, and proper utilization are primary considerations.

<u>Washington State Environmental Policy</u> <u>Act</u>

The Washington State Environmental Policy Act (SEPA) provides a process for analyzing the environmental impact of proposed developments or actions by State agencies. The responsible State agency for approving or implementing a project must disclose its likely adverse environmental impacts and identify mitigation measures to minimize or mitigate significant adverse impacts. A variety of documentation

approaches can be used to satisfy SEPA requirements, ranging from the preparation of a SEPA checklist to the development of an EIS.

For this project, the NEPA requirements and regulations were designed to meet SEPA requirements, which include development and publication of an EIS. The PUDs are the lead State agencies for this EIS. Other applicable State agencies have been contacted through direct phone contact, meetings, and project mailings. These agencies and State representatives have provided input and comment during development of this EIS. The PUDs currently intend to use the Federal EIS to satisfy SEPA requirements, and plan to formally adopt the NEPA review.

Hydraulic Code

The State Hydraulic Code is intended to protect State aquatic resources from damage by construction and other activities. It applies to construction in all marine and fresh waters in the State. The code is implemented through a permit called the Hydraulic Project Approval (HPA) obtained from WDFW for all construction activities within the high water areas of State waters. Some of the activities involved in the alternatives would require this permit.

Local Government Codes and Policies

A variety of local government codes and policies would apply to the programs or activities included in the alternatives. The requirements of all applicable local codes would be identified prior to implementing any new activities, and all necessary permits and approvals would be obtained to ensure that the project developments are in compliance with local laws.

1.5.2.6 Federal Trust Responsibilities to Indian Tribes

Three Tribes (the Confederated Tribes of the Colville Reservation, the Confederated Tribes and Bands of the Yakama Indian Nation, and the

Confederated Tribes of the Umatilla Indian Reservation) and the Columbia River Inter-Tribal Fish Commission have been active participants and commenters in the development of the three HCPs. The Federal government has a trust and legal responsibility to Native American Indian Tribes, which comes from commitments made by the United States in treaties, executive orders, and agreements. Upholding these Tribal rights specified in these commitments constitutes the Federal government's legal responsibility. The Federal government also has a responsibility to consult with affected Tribes whenever its actions affect the resources upon which Tribal hunting. fishing, gathering, and grazing rights depend. Tribal consultation would occur under any of the alternatives selected.

The rights reserved by the Tribes in treaties, established in executive orders and agreements, or that were not expressly terminated by the Congress or the President in the case of executive orders continue to this day. These governmental rights and authorities extend to any natural resources that are reserved by or protected in treaties, executive orders, and Federal statutes. The courts have developed the Canons of Construction, guiding premises, that treaties and other Federal actions "should, when possible, be read as protection of Indian rights in a manner favorable to Indians" (Cohen 1982).

Several issues raised by the Tribes during the HCP negotiating process and during the initial scoping effort for this EIS have been difficult to adequately reconcile. For example, in an effort to preserve stock structure within the listed populations, NMFS indicated that disproportionately high levels of naturally spawning hatchery fish may affect the continued existence of Endangered Species Act-listed species. As a result, NMFS was reluctant to guarantee the 7 percent supplementation levels negotiated in the HCP development process, for the full 50-year term. Without this guarantee, the supplementation levels critical to the Tribes, and an important component of their support for these

agreements, could be modified (i.e., reduced) in certain circumstances.

Without a guarantee from NMFS that the 7 percent compensation levels would be attained under all circumstances, as well as other concerns regarding the mitigation measures set forth in the HCPs, the Yakama and Umatilla Tribes indicated that they would not endorse the HCPs. Certain provisions were added at the request of the Tribes or to otherwise address their concerns. Most notably, NMFS now proposes a series of 10-year hatchery permits for the HCPs' hatchery programs. During implementation of the permits, the full hatchery program will be provided. If NMFS's hatchery policy requires a modification of the hatcheries at the end of the 10-year permits, any party that has signed the HCPs (including the Tribes) has the right to withdraw from the HCPs. In addition, the HCPs now include a number of other legal safeguards for Indian rights.

1.5.3 <u>LISTINGS WITH MAJOR IMPACTS ON</u> APPLICANTS' MANAGEMENT AREAS

NMFS listed Upper Columbia River steelhead and spring-run chinook salmon as endangered under the Endangered Species Act in 1997 and 1999, respectively. Critical habitat for these species was determined to include the mainstem Columbia River and estuary, as well as major Columbia River tributaries known to support these Evolutionarily Significant Units (NMFS 2000c). However, a recent U.S. District Court decision vacated the critical habitat designations for 19 Evolutionarily Significant Units (including the listed Upper Columbia River species). As a result, the critical habitat designations for these species are currently being reevaluated by NMFS.

Although there are currently no critical habitat designations for the Endangered Species Actlisted fish in the Mid-Columbia River region, important spawning and rearing habitat for the Upper Columbia River spring-run chinook salmon includes the Wenatchee, Entiat, and Methow River Basins, as well as the Columbia

River and estuary. In addition to these same areas, important habitat for Upper Columbia River steelhead includes the Okanogan River. The habitat of Upper Columbia River spring-run chinook salmon described above retains its designation as Essential Fish Habitat under the Magnuson-Stevens Act (see above).

USFWS also listed Columbia River bull trout as threatened in 1999. Due to comments on the proposed listing and unresolved issues, USFWS did not make a final rule on critical habitat designations at the time of the listing. In addition, USFWS has not yet made Endangered Species Act Section 4(d) recommendations for the threatened species within the HCPs' management areas. The designation of critical habitat and the 4(d) recommendations are expected within 1 year.

Listed avian and plant species that occur in the project area include the threatened bald eagle and Ute ladies' tresses, respectively. Project effects on these species are evaluated in this EIS.

Over the course of several decades, the PUDs have made physical and operational changes to

their hydropower projects to reduce their effects on anadromous salmonids. In addition, the PUDs began to develop the HCPs in the early 1990s as they recognized the likelihood of future listings and the probable effects on their operations.

Other projects in the Columbia River system have been taking similar steps, and the ongoing operations of the overall system are being coordinated to help improve migratory conditions for anadromous salmonids. Hydropower operations throughout the Columbia River Basin have been found to be one reason for the decline of Columbia River salmon and steelhead. Hydropower development has impacted these species through the loss of habitat above the projects (particularly with the large reservoir projects such as Grand Coulee, where fish passage is currently impossible), and it has increased the degree of mortality during migration (NMFS 1996). There is currently only limited data concerning potential impacts of hydropower development to bull trout populations as is described in Chapters 3 and 4 of this EIS.

1.6 BACKGROUND

The development of the Columbia River hydroelectric system began in the 1930s. Over a period of nearly 40 years, 30 multi-purpose projects on the Columbia River and its tributaries were built by the U.S. Army Corps of Engineers and the Bureau of Reclamation (BOR). Investorowned and publicly owned utilities also built a major system of projects and generating facilities. The projects were designed to meet regional needs of electric power production, land reclamation, flood control, navigation, recreation, and other river uses. During that time, the BPA also built and began to operate transmission lines to deliver the power from these projects, and to market electricity from Federal projects.

As demand for power grew, the United States and Canadian governments negotiated a treaty in the early 1960s for the cooperative use of water storage projects that would be built by both countries in the upper reaches of the Columbia (see Section 1.5.2.5, Other Federal, State, and Local Requirements). Four treaty projects were built, with three on the Columbia River in Canada and a fourth on a major Columbia tributary in Montana. These projects, which were developed in the early 1970s, provide flood control and additional power generation at projects downstream in the United States. The power-generating capability of downstream projects was increased as a result of the treaty storage, including an 18 percent increase at five Mid-Columbia PUD projects.

Over the past several decades, populations of salmon and steelhead throughout the west coast

have declined. Since 1991, NMFS has listed over 20 species of anadromous Pacific salmonids as threatened or endangered. This decline has been particularly notable in the Columbia River system, which includes the Snake River. Before European settlement in the Columbia Basin, between 10 million and 16 million salmon returned to the Columbia each year. By the late 1970s, there were only about 2.5 million salmon, and most of those were of hatchery origin. The NMFS listings noted that the declines were due to many factors, including hydroelectric and irrigation projects; commercial and sport fishing; logging; mining; livestock grazing; water use by farms, cities, and towns; and municipal and industrial pollution. In addition, natural events (such as flooding, landslides, drought, and poor ocean conditions) have impacted fish populations in the Columbia River Basin.

At present, hydropower currently provides about 55 percent of the capacity to meet the Pacific Northwest's energy needs (based on conditions in January 2002). The rapidly increasing human population of the Pacific Northwest will likely result in increased future energy demand in the region. From the most recent data available on Federal energy projections, there would be a deficit of greater than 3,500 average megawatts through the year 2011 (the study years of the analysis), with all months of the year having a deficit. The deficit ranges up to 7,124 average megawatts in year 2011. Because of the region's relatively large reliance upon hydropower, the projected deficits vary substantially dependent on water conditions.

Alternatives to meet future load commitments include (1) purchasing power from new merchant plants operating or under construction in the Pacific Northwest, (2) purchasing power from merchant plants operating outside the Pacific Northwest region, (3) supplementing regional hydro generation using drafting provisions of the Non-Treaty Storage Agreement through June 30, 2003, (4) purchasing off-system storage and exchange agreements that allow for seasonal

shaping of regional hydropower with other regions, and (5) a potential for loads to be lower due to economic conditions, conservation, or more efficient technologies through the study horizon. Regional loads and resource development are dependent on regional and local economies, power prices, and aluminum commodity prices (BPA 2000, updated May 2002).

The three hydroelectric projects provide energy directly to local customers and to utilities, which together serve about 7 million customers in the Pacific Northwest. The Wells Project has a peak generation capacity of 840 megawatts of power, enough energy to serve a city about the size of Portland. This dam provides power to its local customers as well as to Puget Sound Energy, Portland General Electric, PacifiCorp, Avista Corporation, and the Okanogan County PUD. The peak capability of the Rocky Reach Project is 1280 megawatts (enough energy to serve a city about the size of Seattle). The Rocky Reach power distribution area includes residents in Chelan County, as well as the regional BPA grid. The peak capability of the Rock Island Project is 624 megawatts, enough energy to serve a city about the size of Vancouver, Washington. The Rock Island power distribution area includes Wenatchee, the upper valley (including Peshastin-Dryden, Cashmere, and Leavenworth), the BPA transmission grid, and the Puget Sound area.

Each of the three Mid-Columbia River hydropower projects addressed in this EIS has a unique development history, but all projects were developed primarily to serve customers in nearby areas. The physical and operational features of each project reflect its location on the river and the engineering and scientific information that was available at the time the projects were developed. Specific facilities and operations of each of the projects are described in Section 2.2, Project Description.

1.6.1 PLAN AREA

The Plan area is located on the middle reach of the Columbia River, at the geographic center of Washington State. The Columbia River system is the fifth largest (by drainage area) in North America. The river and its tributaries drain an area of 260,000 square miles in seven western states and 39,650 square miles in British Columbia. In the United States, most of the basin is in Washington, Oregon, Idaho, and Montana. The Columbia River originates at Columbia Lake in the Rocky Moutain range of British Columbia, and travels over 1,200 miles to the Pacific Ocean through Washington and Oregon.

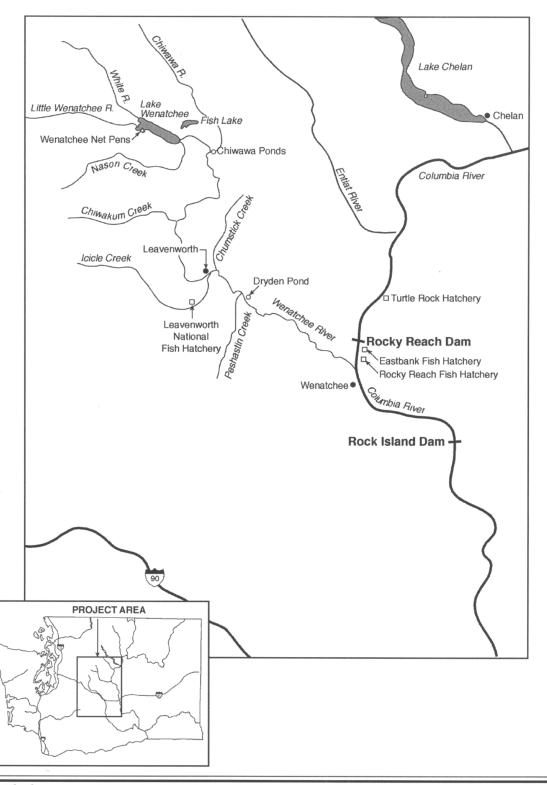
As stated earlier, the Mid-Columbia River reach is defined here as the area of the river between the Chief Joseph Dam tailrace and the confluence of the Yakima River. It contains the three projects covered by this EIS (Wells, Rocky Reach, and Rock Island), as well as two dams (Priest Rapids and Wanapum) operated by Grant County PUD. It also includes the free-flowing Hanford Reach downstream of the Priest Rapids Project. The major tributaries to the Mid-Columbia River are the Okanogan, Methow, Entiat, and Wenatchee Rivers. Note that NMFS's spring-run chinook salmon and steelhead listing determinations refer to species that spawn in this reach as "Upper Columbia River" species.

The three hydropower projects operate on the mainstem of the Mid-Columbia River (Figure 1-2), with the Wells Project at river mile 515.8, the Rocky Reach Project at river mile 474.5, and the Rock Island Project at river mile 453.4. The geographic scope for the analysis has been defined by the physical limits or boundaries of the project's likely direct effects on the resources. It also considers the extent of the contributing effects of other hydropower activities within the Columbia River Basin. The geographic project scope is separated into three tiers associated with direct facility improvements (at the projects), habitat and hatchery improvements (the mainstem between the Chief Joseph and Rock Island

tailraces and the Wenatchee, Entiat, Methow, and Okanogan Rivers), and cumulative effects (including the other projects on the Columbia River).

This EIS evaluates project effects on a tier level, with the first tier representing the major emphasis of the EIS evaluation. The first tier represents the project area described in Section 1.4, Project Location and extends from the tailrace of the Rock Island Dam to the tailrace of the Chief Joseph Dam. The second tier represents the Plan area, which includes the project area and the four tributaries associated with a Tributary Conservation Plan, which addresses improvements to the Wenatchee, Entiat, Methow, and Okanogan River Basins (Figures 1-3 to 1-6). The third tier is associated with cumulative effects of the HCPs with other ongoing and proposed fish protection measures being implemented at other projects in the Columbia River. This tier includes the entire Columbia River from the mouth upstream to Chief Joseph Dam, which is the present upstream terminus for anadromous fish in the Columbia River (see Figure 1-1). Cumulative effects are evaluated in Chapter 5.

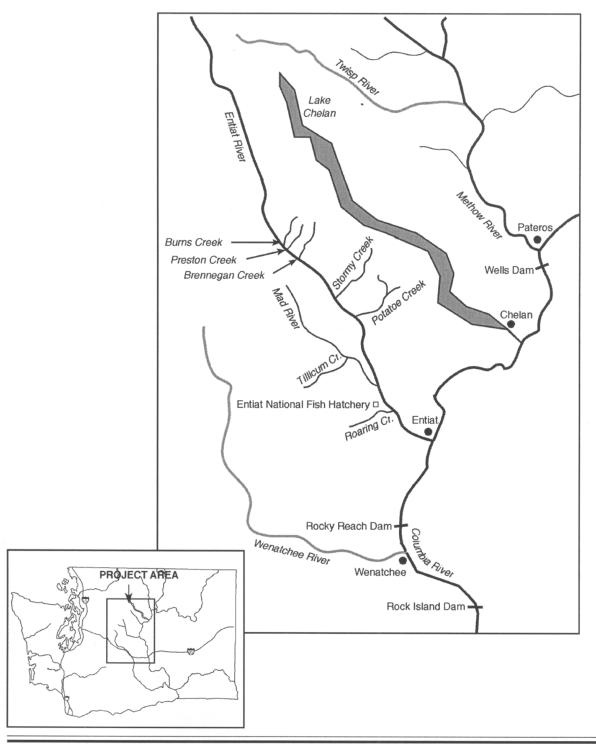
A quantitative fish assessment was conducted by NMFS and funded by the PUDs, the BPA, the Army Corps of Engineers, and the BOR. This assessment is known as the Quantitative Analysis Report (QAR), and is an analysis of proposed conservation measures to improve survival for listed fish species within the Columbia River and the effect that those improvements have upon the probability of recovery and extinction within specified time frames. A QAR summary is provided in Appendix E. The QAR assesses the likelihood that the combined effects of the proposed long-term measures at the PUD and Federal projects will lead to the survival and recovery of the listed species. The QAR does not evaluate additional benefits that might be provided through the hatchery programs but does



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Figure 1-3 Wenatchee River and Associated Creeks and Fish Facilities



Parametrix, Inc. Mid Columbia/553-1543-020(10) 2/00 (K)

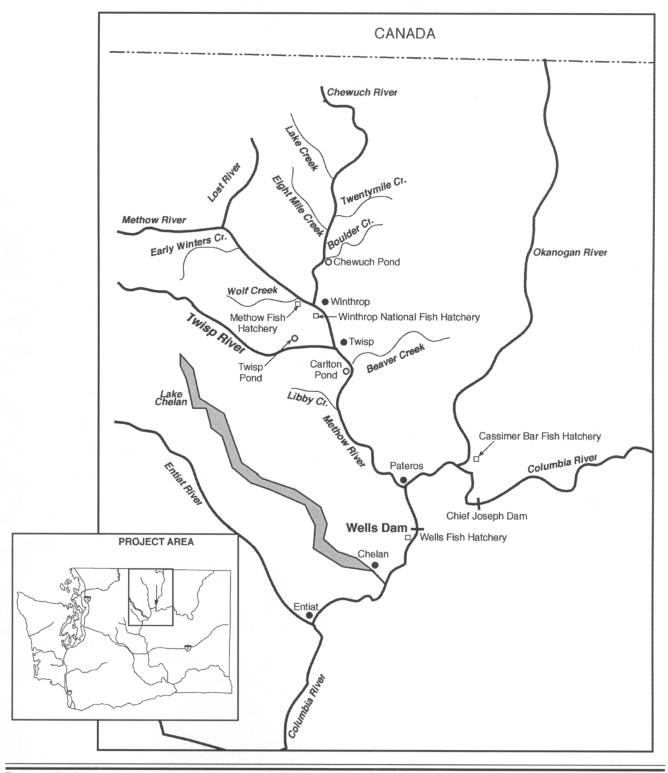


Dam

□ Hatchery

City

Figure 1-4 Entiat River and Associated Creeks and Fish Facilities

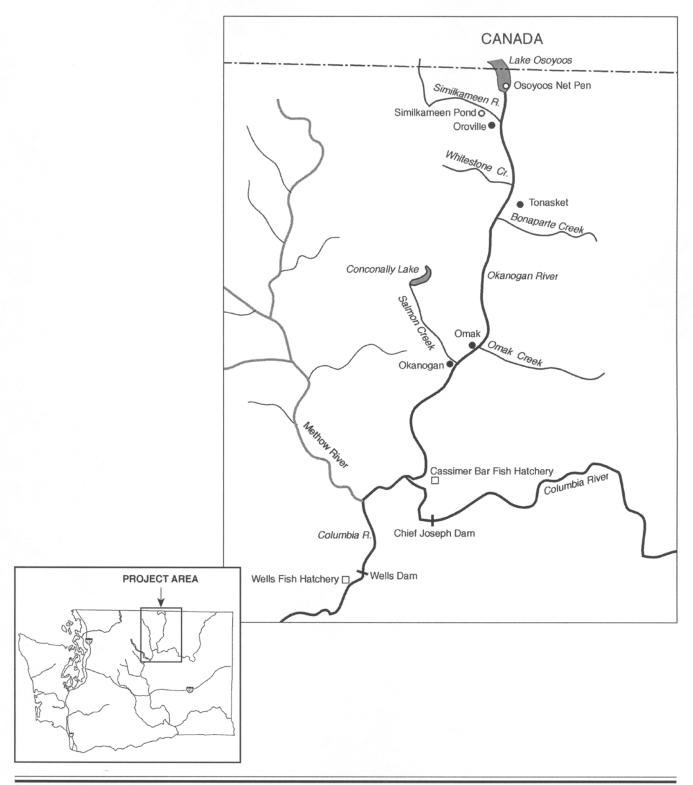


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Dam City
Hatchery o Pond

Figure 1-5 Methow River and Associated Creeks and Fish Facilities



Parametrix, Inc. Mid Columbia/553-1543-020(10) 2/00 (K)



□ Dam□ Hatchery

CityPond

Figure 1-6 Okanogan River and Associated Creeks and Fish Facilities include the expected survival improvement (2 percent) resulting from implementation of the tributary habitat enhancement programs. The findings of the QAR are presented in Chapter 5 of this FEIS under cumulative effects for fish.

Land use throughout the Plan area varies, but it is primarily rural with the exception of the urbanized areas of Wenatchee, East Wenatchee, Pateros, Brewster, and Bridgeport. The other areas include rangeland, irrigated farmlands, and a mixture of private and Federally owned lands. Sections of the Okanogan and Wenatchee National Forests and some Bureau of Land Management (BLM) lands are also found in the drainages within the Plan area.

The Mid-Columbia River area is served by a regional transportation system consisting primarily of Federal and State highways. On the eastern shoreline of the river from the Wells Project going south, there are no roads until U.S. Highway 97 crosses the river at Chelan Falls. Further south at Orondo, U.S. Highway 2 joins with U.S. Highway 97. North of Wenatchee, U.S. Highways 2 and 97 cross the river heading west, while State Route 28 is initiated and continues on the eastern Columbia River shoreline south past the Rock Island Project. On the western side of the river in the vicinity of the Wells Project are U.S. Highway 97 and Alternate U.S. Highway 97, excepting in the vicinity of the Chelan Butte Wildlife Area, where no highways are present. South of the wildlife area is Alternate U.S. Highway 97 south to Wenatchee. State Route 285 then parallels the Columbia River in the vicinity of Wenatchee, and the Malaga Aluminum Company of America (Alcoa) Highway parallels the western shore of the river south past the Rock Island reservoir.

For all three projects, there are no locks, ports, harbors, or smaller navigational channels that provide commercial boat passage between the three projects. Consequently, motor use on the river in the vicinity of the three projects is restricted to recreational use between projects.

Two railroads parallel portions of the Columbia River in the Plan area. The Burlington Northern Railroad follows the western shoreline, while the Rock Island Railroad and the Burlington Northern Railroad extend along the eastern shoreline.

1.6.2 Previous and Ongoing Management Programs in the Plan Area

A wide range of Federal, State, Tribal, utility, and environmental parties are active in the management of the Columbia River and its adjacent resources. Literally hundreds of plans and studies have been conducted in the area.

These include long-range operations plans for the hydropower projects at the system and project levels. Also included are detailed scientific studies focusing on issues such as fish passage, fish habitat, water quality, or other physical elements that affect biological requirements for salmon and steelhead. For the Wells, Rocky Reach, and Rock Island projects, FERC licenses and related documents provide an extensive record on the background of the projects and their operating characteristics, including environmental effects.

Other studies in the area include resource and watershed management plans developed at the State and Federal levels to comply with the requirements of the Clean Water Act, to support natural resource management initiatives (including those required by the Endangered Species Act), and to assist in water rights administration. The plans include scenic, land use, and recreational resource management studies. Also included are scientific and engineering studies conducted by NMFS or USFWS and other studies related to recovery planning, permitting, and mitigating project development. Some of these studies are directly within the HCP planning areas, while others involve issues that either affect the Plan area environment or are influenced by the activities of the Mid-Columbia River hydroelectric projects.

Where appropriate, the HCPs and this EIS refer to these documents in the review of scientific information, and in the analysis of the HCPs' compatibility with other plans and programs.

The following is a brief review of the entities that conduct hydropower and river-related management studies in the Plan area. Where appropriate, the major activities or efforts relevant to the PUD projects and the Mid-Columbia HCPs are identified.

1.6.2.1 Federal Energy Regulatory Commission

FERC conducts an ongoing review of State and Federal comprehensive plans for developing or conserving a waterway. This activity is part of FERC efforts to comply with the Electric Consumers Protection Act of 1986, which ordered FERC to consider each proposed project's consistency with relevant comprehensive plans. Table 1-1 is an October 1999 listing by FERC of the comprehensive plans it has identified in and around the Columbia Basin.

TABLE 1-1. COMPREHENSIVE PLANS IN THE PROJECT AREA

PLAN

- Columbia River Basin Fish and Wildlife Program (1984, 1987, 1994), Northwest Power Planning Council
- Columbia River Fish Management Plan Settlement Agreement, U.S. District Court for the District of Oregon in Case No. 68-513
- · Hydroelectric project assessment guidelines, WDF
- Inland Native Fish Strategy (U.S. Forest Service)
- Instream Resource Protection Program for the Mainstem Columbia River in Washington State, Ecology
- Northwest Conservation and Electric Power Plan, Northwest Power Planning Council
- Okanogan National Forest Land and Resource Management Plan, U.S. Forest Service
- · Protected Areas Amendments and Response to Comments, Northwest Power Planning Council
- Resource Protection Planning Process Mid-Columbia Study Unit, Department of Community Development. Washington Office
 of Archaeology and Historic Preservation
- Scenic Rivers Program Report, Washington State Parks and Recreation Commission
- Shorelands and Coastal Zone Management Program, Ecology
- Shorelands and Water Resources Program State Wetlands Integration Strategy, Ecology
- State of Washington Natural Heritage Plan, Washington Department of Natural Resources
- State Scenic River System Act, Chapter 79.72 RCW
- 1987 Strategies for Washington's Wildlife, Washington Department of Game
- Voices of Washington, Interagency Committee for Outdoor Recreation
- Washington Outdoors: Assessment and Policy Plan, Washington State Interagency Committee for Outdoor Recreation
- Washington State Hydropower Development/Resource Protection Plan, Energy Office
- Washington State Scenic River Assessment, Washington State Parks and Recreation Commission
- Washington's Statewide Comprehensive Outdoor Recreation Plan, Sixth Edition, Interagency Committee for Outdoor Recreation (1985,1995)
- · Washington State Wetlands Integration Strategy, Ecology
- Water Resources Management Program Methow River Basin, Ecology
- Water Resources Management Program Okanogan River Basin, Ecology
- Water Resources Management Program Entiat River Basin, Ecology
- Water Resources Management Program Wenatchee River Basin, Ecology
- Wenatchee National Forest Land and Resource Management Plan, USFS
- · Wenatchee River Basin Instream Resources Protection Program, Ecology

Source: FERC (2002)

1.6.2.2 National Marine Fisheries Service

Many of NMFS's past studies, listings, and rules are relevant to the Mid-Columbia hydroelectric projects. Currently, the most significant document, aside from the listings themselves, is the 2000 biological opinion for the reinitiation of consultation on the operation of the Federal Columbia River Power System, including the Juvenile Fish Transportation Project and 19 BOR projects in the Columbia Basin (NMFS 2000a). This biological opinion superseded NMFS's 1995 biological opinion on the operation of the Federal Columbia River Power System (NMFS 1995) and 1998 supplemental biological opinion for steelhead (NMFS 1998a) and evaluated the effects of the operation of Federal Snake and Columbia River storage and run-of-the-river dams on listed anadromous salmonids.

The effects of the Federal Columbia River Power System projects were evaluated in the context of other factors influencing the survival of listed species. NMFS's expectations regarding operation of Mid-Columbia FERC projects were explicitly included in this analysis. Expectations for other Federal activities were documented in the Basinwide Salmon Recovery Strategy (Strategy). The Strategy also includes expectations for the Mid-Columbia FERClicensed projects. The Strategy describes measures that the Federal dam operators and other Federal agencies committed to implement to improve the likelihood of recovery for listed salmon and steelhead. The 2000 Federal Columbia River Power System biological opinion incorporated and further refined those actions identified in the Strategy as the responsibility of the dam operators as part of an off-site mitigation program to offset effects of the Federal dams on listed anadromous salmonids. These specific offsite mitigation measures, deemed necessary for the survival and recovery of the listed species, are included in the 2000 Federal Columbia River Power System biological opinion's reasonable and prudent alternative.

In addition to the biological opinion for the Federal Columbia River Power System, NMFS has completed biological opinions for the Wells and Rocky Reach projects. The Wells biological opinion (NMFS 2000b) addressed the continued operation of the Wells Project under a proposed interim protection plan through April 2002. Although the timeframe of this consultation has expired, Douglas County PUD continues to operate the Wells Project in accordance with the biological opinion and the interim protection plan, pending the results of the actions proposed in this EIS.

NMFS has also completed the Section 7 consultation for the interim operation of the Rocky Reach Project (through 2006), including the construction and operation of a juvenile fish bypass system. This biological opinion would be superceded by the Rocky Reach HCP, or through the reinitiation of consultation during project relicensing in 2006.

1.6.2.3 Bonneville Power Administration, U.S. Department of Energy

BPA is the sole Federal power-marketing agency in the Northwest and the region's major wholesaler of electricity. Created by Congress in 1937, BPA services the States of Washington, Oregon, Idaho, Montana (west of the Continental Divide), and small adjacent portions of California, Nevada, Utah, and Wyoming. BPA markets and transmits power, coordinates operation of the Federal Columbia River Power System, and manages a large portion of the Pacific Northwest-Pacific Southwest Intertie. Although it lacks authority to build or own dams or power plants, BPA does own and operate, within its service area, the nation's largest network of long-distance, high-voltage transmission lines. BPA is part of the U.S. Department of Energy, but is not funded by tax revenues; the agency recovers the cost of operations and maintenance mainly through its electricity rates.

1.6.2.4 U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers owns and operates eight Federal hydropower projects on the Lower Columbia and Snake Rivers. This includes the McNary, John Day, The Dalles, and Bonneville projects on the Lower Columbia. The Army Corps of Engineers also operates Chief Joseph Dam, located immediately upstream of the Wells Dam reservoir. The Army Corps of Engineers is responsible for implementing the Columbia River Fisheries Management Program for its projects. The management program is largely based on measures contained in NMFS's biological opinions on the impacts of the Federal hydropower system operations on Columbia and Snake River salmon and steelhead, including the 2000 biological opinion for the Federal Columbia River Power System (NMFS 2000a). In addition, the Army Corps of Engineers' program considers and implements capital construction measures for mainstem fish passage.

1.6.2.5 Northwest Power Planning Council and the Columbia River Basin Fish and Wildlife Program

The Northwest Power Planning Council is a four-state compact formed under the Northwest Power Act. Through the Council, Idaho, Montana, Oregon, and Washington oversee electric power system planning and fish and wildlife recovery in the Columbia River Basin. The Council has no direct authority over utilities, but it works closely with Northwest utilities and State regulatory commissions. The Council's responsibility is to mitigate the impact of hydropower dams on all fish and wildlife in the Columbia River Basin, including endangered species, through a program of enhancement and protection.

The Northwest Power Act gave the Council three distinct responsibilities: (1) to ensure that the region has an adequate, efficient, economical, and reliable electric power supply; (2) to prepare a program to protect, mitigate actions that might harm, and enhance fish and wildlife populations

of the Columbia River Basin that have been affected by the construction and operation of hydropower projects; and (3) to inform the Pacific Northwest public about energy issues and involve the public in decision-making.

Recent studies by the Council include a reliability study of the Northwest power system loads and resources, and a review of Columbia River Basin fish and wildlife decision-making processes. One of the Council's largest ongoing programs is the Columbia River Basin Fish and Wildlife Program.

The Columbia River Basin Fish and Wildlife Program was the first comprehensive strategy for fish and wildlife in the Columbia River Basin. The Council's 2000 Fish and Wildlife Program addresses the activities that affect fish and wildlife in the Columbia River Basin, specifically hydropower, habitat, hatcheries, and harvest. Through its fish and wildlife program, the Council provides guidance and recommendations on hundreds of millions of dollars per year of BPA revenues to mitigate the impact of hydropower on fish and wildlife. That amount is expected to increase in the future as enhancement efforts expand and accelerate.

The Northwest Power Act required the plan to address the following issues: (1) environmental quality, (2) compatibility with the existing regional power system, and (3) protection, mitigation of actions that might harm, and enhancement of fish and wildlife populations and related spawning grounds and habitat (including sufficient quantities and qualities of flows for successful migration, survival, and propagation of anadromous fish). The four key directives in the Council's fish and wildlife program regarding anadromous fish are to improve migration survival, reduce harvest of wild fish, protect and improve habitat, and improve hatcheries.

1.6.2.6 Fish Passage Center

The Fish Passage Center is an entity established by the Northwest Power Planning Council's Fish and Wildlife Program, with funding provided by BPA. The Fish Passage Center participates in coordinating river flows for fish migration at mainstem Columbia and Snake River hydroelectric projects, both Federal and non-Federal. The Fish Passage Center provides technical support and data for the agencies and Tribal members in planning and implementing operation of the hydroelectric system. It provides extensive data on flow and passage mitigation measures related to the Council's Fish and Wildlife Program and the NMFS biological opinions.

1.6.2.7 Bureau of Indian Affairs, U.S. Department of the Interior

The Bureau of Indian Affairs (BIA) is charged with carrying out the major portion of the trust responsibility of the United States to Native American Indian Tribes. This trust includes the protection and enhancement of Indian lands and natural resources through technical assistance and management and mineral resource management.

1.6.2.8 Bureau of Land Management, U.S. Department of the Interior

BLM is responsible for the management of 281 million acres of public lands located primarily in the western states and Alaska. Resources managed by BLM include timber, hard minerals, oil and gas, geothermal energy, wildlife habitat, endangered plant and animal species, rangeland vegetation, recreation and cultural values, wild and scenic rivers, designated conservation and wilderness areas, and open space. Hanford Reach, the last free-flowing reach in the Lower Columbia River, located downstream of the Priest Rapids hydroelectric project, has been designated a historical monument. Some of the lands

adjacent to the Mid-Columbia reach are also Federal public lands managed by BLM.

1.6.2.9 Bureau of Reclamation, U.S. Department of the Interior

BOR administers Federal programs in the 17 western states for water resource management, and owns and operates a number of dams in the Northwest, including Grand Coulee Dam upriver of the Mid-Columbia projects. It also owns and operates several projects on the tributaries of the Columbia River. Grand Coulee Dam is part of the Columbia Basin Project managed by BOR, which provides irrigation water to about 671,000 acres of the Columbia Plateau. This project extends from Grand Coulee Dam, about 125 miles south to near Pasco, Washington. Operations at this project include flood control, storage, generation, irrigation, and salmon flow augmentation. These operations have a significant impact on flows in the Mid-Columbia reach.

1.6.2.10 U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (USEPA) is responsible for managing and enforcing water quality regulations in the nation's waters. It also regulates discharge of pollutants into water and air. Under the Clean Water Act, USEPA, the State, Tribal governments, other Federal agencies, and private landowners implement numerous programs throughout the Columbia River Basin to improve water quality in associated watersheds and tributaries. The programs implemented in the Columbia River mainstem and tributaries focus on improving water quality, restoration of habitat, and recovery of Endangered Species Act-listed species. In Washington State, Ecology has been charged by USEPA to implement the provisions of the Clean Water Act. USEPA is also responsible for reviewing this EIS pursuant to Section 309 of the Clean Air Act.

1.6.2.11 Columbia Basin Fish and Wildlife Authority

The Columbia Basin Fish and Wildlife Authority is an association of fish and wildlife agencies from the four states, two Federal agencies, and 12 Indian Tribes in the Columbia River Basin. Its mission is to coordinate planning and implementation of the fish and wildlife management issues in dealings with the Northwest Power Planning Council, BPA, and Army Corps of Engineers. It is a non-regulatory party, and presents only consensus positions of its members.

1.6.2.12 Columbia River Inter-Tribal Fish Commission

This commission represents four Columbia Basin Indian Tribes that signed treaties in 1855 securing to them certain reserved rights to take fish in the Columbia River and its tributaries. The Commission is composed of the fish and wildlife committees of its member Tribes and supplies technical expertise and enforcement resources.

1.6.2.13 Columbia River Treaty Tribes

Four Columbia River Basin Tribes have reserved rights to anadromous fish, provided through an 1855 treaty with the United States. The four treaty Tribes are the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes and Bands of the Yakama Indian Nation. A fifth tribal organization, the Confederated Tribes of the Colville Reservation, was not specifically named in the 1855 treaty, but the Colville confederation includes part of the Nez Perce Tribe.

From 1905 through the present, a series of Congressional Acts and Federal court rulings have clarified Tribal treaty fishing rights, and determined the various responsibilities of State and Federal agencies to co-manage basin resources with the Tribes and regulate treaty fisheries for conservation purposes. Below, the Tribes are briefly described, based on information provided by the Columbia River Inter-Tribal Fish Commission. Summary information on the Tribes is provided below.

The Nez Perce Tribe

The Nez Perce homeland once covered 12.3 million acres in what is now Idaho, Oregon, and Washington. Today, the reservation consists of 741,300 acres, of which 13 percent is owned by the Tribe. The Nez Perce co-manage and fish in several Columbia River basin tributaries, including the mainstem Columbia. The Tribe has an enrolled membership of about 3,000 and is headquartered in Lapwai, Idaho.

The Confederated Tribes of the Colville Reservation

The reservation of the Confederated Tribes of the Colville Reservation was established by President Grant's Executive Order in 1872. The 12 Tribes located there are the Okanogan, Lakes, Colville, San Poli, Nespelem, Methow, Entiat, Chelan, Wenatchee, Moses-Columbia, Palouse, and Nez Perce. The 1,397,500-acre reservation in the north central section of Washington State is bounded on the east and south by the Columbia River and on the west by the Okanogan River, and includes 4,528 Colville Indians residing on Tribal land.

The Confederated Tribes and Bands of the Yakama Indian Nation

The Yakama Indian Nation includes 14 bands and Tribes, including the Kah-milt-pah, Klickitat, Klinquit, Kow-was-say-ee, Li-ay-was, Ochechotes, Palouse, Pisquose, Se-ap-cat, Shyiks, Skinpah, Wenatshapam, Wishram, and Yakama. The 1,185,000-acre Yakama Indian Reservation is in south central Washington, and includes

7,411 Yakama Indians residing on Tribal land. The Yakama Indian Nation co-manages the Columbia River, as well as the Wind, White Salmon, Klickitat, Yakima, Wenatchee, Methow, Entiat, and Okanogan Rivers, and fishes in many locations in the greater basin.

The Confederated Tribes of the Umatilla Indian Reservation

The confederation of the Walla Walla, Cayuse, and Umatilla Tribes shared a homeland in what is now northeastern Oregon and southeastern Washington. Today the three-Tribe confederation numbers 1,500, and much of the Tribal reservation (172,882 acres) is in the Umatilla and Grande Ronde River watersheds in Oregon. The Tribe has co-management responsibilities for several Columbia Basin rivers, including the mainstem Columbia. Most of its fishing and conservation activities occur along the Umatilla, Grande Ronde, and Columbia Rivers, below the confluence of the Snake and Columbia Rivers.

The Confederated Tribes of the Warm Springs Reservation of Oregon

The three Tribes in this confederation are the Warm Springs, Wasco, and Paiute headquartered in Warm Springs, Oregon. The reservation is approximately 644,000 acres, with 4,528 Native Indians residing on these lands. The Warm Springs Tribe co-manages the Columbia, Deschutes, Fifteenmile Creek, John Day, and Hood River watersheds, but is typically not an active participant in the management of the Mid-Columbia reach. However, their fishing activities are affected by the health of Mid-Columbia stocks.

1.6.3 OTHER CONTRACTS AND AGREEMENTS

1.6.3.1 Mid-Columbia PUD FERC Agreements

The licenses for the three Mid-Columbia hydroelectric projects include agreements with the Colville, Yakama, Umatilla, and Warm Springs Tribes; State and Federal fisheries agencies; and major wholesale power purchasers. The agreements address issues including juvenile fish passage, hatchery operations, project modifications, and studies related to anadromous fish.

Douglas County PUD entered into the Wells Settlement Agreement for the Wells Project in 1990 (FERC 1990). Although the agreement for the Rocky Reach Project (Fourth Revised Interim Stipulation) has expired, Chelan County PUD continues to operate the project under the interim stipulation in most years (FERC 1995). For the Rock Island Project, Chelan County PUD has entered into the Rock Island Settlement Agreement (FERC 1987a). Chelan and Douglas County PUDs are also parties to the Vernita Bar Settlement Agreement for the protection of the Hanford Reach of the Columbia River.

1.6.3.2 Major Bond and Sales Agreements for the Projects

The projects owned by the Chelan and Douglas County PUDs have different development and financing histories. However, long-term bonds and sales contracts are two major elements affecting their operations. Salmon and steelhead issues affect the PUDs' power costs, energy produced, capacity to generate energy, bond ratings, and their ability to enter future long-term sales contracts. Increasing the predictability of these effects, along with protecting the Plan species, is the major reason why the PUDs are seeking an incidental take permit with a 50-year term.

Through long-term contracts, Chelan County PUD sells about 63 percent of its hydroelectric power at cost to utilities in the Northwest. The PUD finances its hydropower projects through bonds dedicated to each project, and through consolidated bond offerings that also fund its power distribution and water/wastewater systems. The Douglas County PUD sells about 62 percent of its power through long-term contracts. The major financing bonds and sales contracts for the PUDs and their projects are described below.

The Douglas County PUD began developing the Wells Project in 1963, and completed the project in 1967. The development was funded through revenue bonds. In 1975, 1986, 1990, and 1993, additional bonds were issued for various project improvements and to fund programs required under the project's license and other agreements. As of 1999, the PUD had \$168.7 million in bonds outstanding.

Through long-term sales contracts that continue to 2018, 100 percent of the power generated by Wells is sold to PacifiCorp, Puget Sound Energy, Portland General Electric Company, Avista Corporation, and the PUD's distribution system. In addition, the PUD has a power sales contract with the PUD No. 1 of Okanogan County, in which the PUD sells 8/38 of its share of the output of the Wells Project to Okanogan PUD and entitles Okanogan PUD to an 8-percent interest in the project after all acquisition and construction debts are repaid. The contracts allow the PUD to recover production costs for the Wells Project.

The Rocky Reach Project was developed and financed by Chelan County PUD through the sale of revenue bonds, which pledged revenues from the project for debt repayment. The original project was financed with \$273.1 million of revenue bonds in 1956 and 1957. Additional project improvements for generation, recreation, fish protection, and other features have also been financed by revenue bonds. As of 2001, an estimated \$886,076,000 in revenue bonds secured by the Douglas County PUD's consolidated hydrosystem were outstanding.

The repayment of the revenue bonds has been guaranteed through power sales contracts between Chelan County PUD and PacifiCorp, Portland General Electric Company, Puget Sound Energy, Inc. (formerly Puget Sound Power & Light), Avista Corporation (formerly Washington Water Power Company), Alcoa, Douglas County PUD, and the PUD's electric distribution system. Most of the contracts cover a 50-year period that started after the November 1961 date of commercial operation, and they expire in October 2011. The current contracts for Rocky Reach allow the PUD to recover production costs, and the PUD can sell its excess power at market rates (Chelan County PUD 1999a).

The Rock Island Project was first developed by Puget Sound Energy in 1930, and was purchased by Chelan County PUD in 1956. A second powerhouse was added to the project in 1979. All of the power from the project is sold to Puget Sound Energy and to the PUD's distribution system (Chelan County PUD 1999a).

1.7 Public Scoping, DEIS Review, and NMFS's Response

Public scoping for the environmental review of the permit applications began with publication of a Notice of Intent in the Federal Register on January 6, 1999 (64 Federal Register 123098E) Subsequently, a scoping brochure was distributed to all parties requesting additional information after the Notice of Intent was published, as well as to individuals, agencies, businesses, or organizations known to have an interest in the hydroelectric projects, the HCPs, or other aspects of the study area. The mailing list included over 285 individuals, agencies, private businesses, and organizations. Both the Notice of Intent and the brochure described the project's public scoping

period, which lasted through February 5, 1999. The brochure included notice of project scoping meetings, and notices of the meetings were also advertised in local newspapers.

Scoping meetings were held on January 20, 1999 in Wenatchee, Washington and on January 21, 1999 in Brewster, Washington. Oral comments were solicited at the meetings, and written comments were received throughout the scoping period. Additional resource agency comments were also received as a result of a scoping and alternatives development meeting held on March 3, 1999. Using results from the scoping meetings, NMFS and the project applicants refined the scope of the projects and alternatives.

The meetings also helped highlight areas of special concern, which included environmental protection, Endangered Species Act compliance, and impacts to society and economic conditions. Comments expressed opinions on alternative preferences, monitoring and measurement, and cultural resources, as well as requests for additional information on the regulatory context and requirements for hydropower project licensing, and implementation and interpretation of the No Surprises policy.

Ten primary issues were identified during public scoping for the DEIS as summarized below:

• Endangered Species Act Compliance: How will Sections 7 and 10 assurances be applied to the action alternatives, including the No Surprises policy? A detailed description of how the alternatives meet Endangered Species Act compliance is provided in Section 2.6, Alternative Comparison and in Table 2-7, Comparison of Alternatives for Anadromous Salmonid Conservation Measures. The No Surprises policy is discussed in Section 1.5.2.1 Endangered Species Act Requirements for Non-Federal Actions.

- Anadromous Fish Protection: What fish protection and monitoring measures will be applied (including fish screens), what impacts would occur to the Permit species if survival goals are not met, and how would the introduction of coho affect the existing fisheries resources? The fish protection measures for the action alternatives are described in Section 2.3, Alternatives Considered in Detail. Impacts that would occur to Permit species are described in Section 3.2, Fisheries Resources (including coho salmon).
- Economic Viability: Will HCP funding be achievable, and what is the justification for the proposed funding levels? Refer to Section 4.8, Economics, for a discussion of the cost differences among the alternatives and how the PUDs will obtain the funding needed. The rationale for establishing the HCP funding levels is addressed in Section 2.3.4.8, HCP Conservation Plan and Compensation Measures.
- Recreation: How would implementation of the HCPs affect the socioeconomic conditions of surrounding communities, especially recreation-related tourism? Refer to Section 4.7, Socioeconomics for a discussion of the socioeconomic effects of the action alternatives.
- TribalTreaties/Cultural Resources: Will the HCPs satisfy the Federal Trust Responsibility and other Secretarial Orders and Tribal treaties? What are the potential impacts of the action alternatives on cultural resources, especially salmon and lamprey? Section 4.12.17, Legislation Pertinent to Tribal Governments describes how the alternatives meet Tribal responsibilities. Alternative impacts on salmon and lamprey are described in Section 4.2, Fisheries Resources.

- Geology and Water: How will the HCPs affect flood control, sedimentation, and water use? Geology, soils, and water resource effects from implementation of the alternatives are described in Section 4.1, Land Features, Geology, and Soils, and Section 4.3 Water Resources.
- Alternatives: Will alternatives be developed that include dam removal, drawdown, and non-power operations? Will any alternative not involve the taking of imperiled salmonids? The action alternatives include drawdown. Non-power operations (including dam removal) are discussed in Section 2.5, Alternatives Considered But Eliminated from Detailed Consideration. All alternatives involve hydropower operations where the taking of salmonids would occur.
- Baseline Conditions: How will baseline conditions be defined in the analysis?

 Alternative 1 represents baseline conditions, and is described in Section 2.3.2, Alternative 1.
- Regulatory Agency Requests: How will compliance with other laws and regulations be addressed in the NEPA process?

 Compliance with laws and regulations is described in Section 4.12, Relationship to Laws and Policies, as well as in each of the resource sections in Chapter 4.
- **Cumulative Effects**: How will cumulative effects be addressed in the EIS? Chapter 5 describes the cumulative effects by resource.

Where pertinent, the issues identified during public scoping were used to develop alternatives. These include consideration of a fish bypass for an action alternative, dam drawdown, Endangered Species Act compliance, monitoring, the development of survival goals, and demonstration of economic viability. All action alternatives were developed in consideration of Tribal treaty rights, Federal Trust responsibility, Secretarial

Orders, and other regulatory compliance requirements.

Following development of the alternatives, a cooperating and participatory agency/organization meeting was held on September 9, 1999 to describe the alternatives and scoping comments received.

The DEIS was published on December 29, 2000 for public review (65 Federal Register 82976). On April 16, 2001, NMFS reopened the comment period on the DEIS in response to requests for extension of the comment period (66 Federal Register 19426). From public comments received on the DEIS, there were questions involving the implementation, regulation, and monitoring components of the HCPs that needed to be further defined prior to publication of the FEIS. Refer to Appendices A (public comments received at DEIS public meetings) and B (written comments received on the DEIS). NMFS responses to public comments are provided in Appendix C. The applicants also commented on the DEIS. Their comments and NMFS's responses are included in Appendix D. In addition, where needed, the FEIS has been changed to include information requested from public comment.

Issues that arose during the DEIS public comment period included 39 specific areas, and some miscellaneous comments (Appendix C). Many comments included the request for more detail and discussion either in the HCPs or the EIS on the expected implementation process. These comments were addressed through HCP and EIS revisions that provided additional detail. Other comments include those already identified above during the scoping process. Unique issues brought forth during the DEIS public comment period that are in addition to requests for clarification are described below:

• Water Quality: How will the action alternatives meet compliance with the Clean Water Act? The EIS alternatives were primarily developed to meet Endangered

Species Act compliance. However, implementation of any EIS alternative will require compliance with all Federal, State, and local laws and regulations. Clean Water Act compliance is addressed in the HCPs in Section 5, Reservoir as Habitat and Water Quality for the Wells HCP and in Section 6, Reservoir Habitat and Water Quality in the Rocky Reach and Rock Island HCPs.

- **Biological Opinion**: Will a biological opinion be prepared for this project? The biological opinion will be available for public review upon issuance of the Record of Decision.
- Adequacy of the Off-Site Mitigation Plans: Is a 2 percent mitigation fund (Plan Species Account) adequate in the HCPs? The HCPs were revised to include a Tributary Assessment Program as described in Section 7.5, Tributary Assessment Program for the Wells HCP and Section 7.6, Tributary Assessment Program for the Rocky Reach and Rock Island HCPs.
- **Hatchery Plan**: Will the Tribes be guaranteed hatchery compensation as currently occurs? Section 8.4.3, Phase I Production Commitment; Section 8.4.5, Adjustment of Hatchery Compensation – Population Dynamics of the Wells HCP; Section 8.4.2, Calculation of Hatchery Levels; and Section 8.7, Program Review in the Rocky Reach and Rock Island HCPs specify the hatchery production levels under the HCP through 2013. The hatchery programs would be evaluated in 2013 and every 10 years thereafter to determine if hatchery program goals and objectives (as defined in the Section 10 Endangered Species Act permits and in the HCP and supporting documents) have been met. Based on this review, production levels would be established for the next 10-year period.

- Monitoring: Will adequate monitoring occur to confirm that HCP no net impact goals are being achieved? Monitoring for achievement of the survival standard has been revised in the HCPs to ensure that the appropriate studies are conducted and the coordinating committees approve the conclusions. Refer to Section 4 Passage Survival Plan for the Wells HCP and Section 5 Passage Survival Plan for the Rocky Reach and Rock Island HCPs.
- Attainment of Survival Goals: What assurances are there that the HCP survival standards will be met? The HCPs were revised to ensure that the no net impact standard would be achieved no later than 2013. Refer to HCP Section 3.1 in the Wells, Rocky Reach, and Rock Island HCPs.
- Other Existing Agreements: How will the HCPs affect relicensing and the Mid-Columbia Proceedings? The FEIS Section 1.5.2 Overview of Federal Requirements for Species Conservation describes how the alternatives affect the current project evaluations by affected parties.

During 2001 and 2002, negotiations were conducted among the interested parties to address the issues identified during public comment on the DEIS. NMFS held over 20 meetings with State and Federal resource agencies, Tribes, and American Rivers. These discussions resulted in revised HCPs for all three Mid-Columbia River projects in March 2002. The PUDs, NMFS, USFWS, WDFW, the Colville Tribe signed these HCPs, and the Wells HCP was also signed by Douglas County PUD's wholesale power purchasers.

NMFS is not obligated under the HCPs to issue the PUDs Section 10 permits unless, after completion of the NEPA process and other environmental analyses, NMFS can make the appropriate Section 10 findings. Implementation of the agreements is contingent upon NMFS's issuance of the Section 10 permit and FERC's

amendment of the project licenses. Notice of the revised applications for incidental take permits and availability for public comment was published by NMFS in the Federal Register (67 Federal Register 42755) on June 25, 2002. NMFS received comments on the Federal Register notice through July 29, 2002. Responses to comments received were reviewed and considered during preparation of this FEIS. NMFS's written response to the comments will be included in the ROD for this project. This FEIS evaluates the revised HCPs.

The revised HCPs provide greater detail regarding the implementation and monitoring procedures, although the fundamental structure of the HCPs remains unchanged as described in the DEIS. The HCPs maintain the primary objective of producing no net impact to the Plan species through a 91 percent combined adult and juvenile project survival standard, and mitigation for the 9 percent unavoidable mortality at each project through hatchery supplementation and tributary enhancement programs.

Although the 91 percent survival standard was maintained, the parties acknowledged the difficulty of measuring adult survival with existing technology. However, instead of abandoning the 91 percent standard, the parties created a measurement surrogate until it becomes possible to adequately measure adult survival. This interim surrogate survival measurement is a 93 percent juvenile project survival goal derived by assuming a 0 to 2 percent adult mortality attributable to each project, which is based on the best available data.

In addition to clearly defining the survival standards, the HCP supporting documents identify the current best available measurement technology and the appropriate uses of the technology to evaluate the standards. The revised HCPs clearly define what constitutes a valid survival estimate. Coordinating committees are identified as the primary means of consultation and coordination between the PUDs and the

fisheries parties in connection with conducting studies, implementing the HCP measures, and resolving disputes. The hatchery and tributary committees would operate as described in the DEIS; however, each project would have separate coordinating, hatchery, and tributary committees.

The revised HCPs clarify the PUDs' responsibilities relative to the level of accuracy associated with the measurement of the survival rates. This provides a clear decision-making process for the coordinating committees to determine if the survival standards are met, and actions necessary to achieve or maintain the established protection levels for each Plan species.

Although the 7 percent hatchery supplementation rate also remains unchanged, the revised HCPs provide more details about monitoring and evaluation of the hatchery plan, and better define the types and numbers of fish to be produced, and how the hatchery program will be implemented in relation to changes in NMFS hatchery policies. The 2002 HCPs expressly provide for the production of coho salmon and Okanogan River Basin spring-run chinook salmon.

The tributary enhancement program remains the same in the revised HCPs, although Douglas County PUD agreed to double its initial contribution to the Tributary Fund to \$1,982,000 (1998 dollars). The parties also added a Tributary Assessment Program to which each project would contribute up to \$200,000 to evaluate the relative merits of individual tributary enhancement projects or an aggregation of several projects.

Other changes in the HCPs included:

- specific provisions for dam operations during the regulatory review process,
- a more detailed description of HCP phase designations,
- the addition of a survival standard decision matrix,

- changes in dispute resolution procedures,
- the agreement that water quality issues will be addressed by all parties,
- the acknowledgement that the Wells Project has already achieved the 93 percent juvenile project survival goal for certain species,
- clarification of the HCP initiation dates for the 50-year time period,

- a more defined description of withdrawal and termination events,
- confirmation that the HCPs will comply with applicable laws, and
- a requirement that the no net impact standard will be achieved no later than 2013.

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CHANGES MADE BETWEEN THE DEIS AND THE FEIS FOR CHAPTER 2

- Changes in Chapter 2 have been made to reflect or address public comments on the Draft EIS, or to otherwise refine the EIS.
- In general, redundancies within and between Chapters 2 and 1 have been eliminated.
- Definitions of kelt, Permit species, and Plan species have been included in the Key Terms.
- Project descriptions and effects were updated and expanded to include new criteria for project operations, the most recent survival studies, and a more comprehensive treatment of the factors affecting fish survival in the project areas. This additional information is also updated in the description of Alternative 1 (no-action).
- Changes were made in Chapter 2 that reflect changes made to the HCPs that resulted from the
 public and agency DEIS review comments as summarized in Section 1.7, Public Scoping, DEIS
 Review, and NMFS's Response.
- Section 2.7, Preferred Alternative, was added to identify the preferred alternative and provide a bulleted summary of the major NEPA and Endangered Species Act-related issues that NMFS has considered in its decision.
- Alternative 1 was altered to include the completed Section 7 consultation for Rocky Reach Dam for the construction and operation of a juvenile fish bypass system and the continued operation of the project through relicensing in 2006. However, because the bypass is an integral part of the HCP, it is still evaluated under Alternative 3.
- Alternative 2 was expanded to include more comprehensive conservation measures as requested through public comments on the DEIS.

Chapter

2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

Key Terms

- **FERC License** A Federal license for hydroelectric projects that includes requirements and restrictions about how the projects are maintained and operated. The PUD hydroelectric projects are licensed by the Federal Energy Regulatory Commission (FERC), under the Federal Power Act.
- **Fish Passage Facilities** The features of a dam that enable fish to move around, through, or over a dam. Facilities generally include an upstream fishladder and/or a downstream bypass system. A fishladder is a series of ascending pools constructed to enable salmon or other fish to swim upstream past the dam or barrier. A bypass system is a structure that provides a route for fish to move through or around the dam without going through turbine units..
- **Kelt** Adult steelhead that have completed spawning and are migrating downstream to return to the ocean.
- No Net Impact An objective of the HCPs is to achieve "no net impact" for each Plan species affected by the Wells, Rocky Reach, and Rock Island hydroelectric projects. The no net impact standard consists of two primary components: 91 percent combined adult and juvenile survival for all anadromous salmonid species migrating through each project, and compensation for the 9 percent unavoidable project mortality. The PUDs would compensate for the 9 percent fish loss at the projects through hatchery compensation programs and funding the tributary habitat programs. Hatcheries would compensate for 7 percent fish mortality at the projects. Habitat improvements in the Mid-Columbia River tributaries would compensate for the remaining 2 percent mortality. This compensation for project mortality would result in a no net impact standard at the three projects.
- **Permit Species** For the purposes of this EIS, Permit species are all Plan species except coho salmon (*Oncorhynchus kisutch*). Permit species do not include coho salmon since wild coho salmon are extirpated from the Mid-Columbia region and therefore not protected by the Endangered Species Act.
- **Plan Species** For the purposes of this EIS, Plan species are spring-run and summer/fall-run chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*O. nerka*), coho salmon (*O. kisutch*), and steelhead (*O. mykiss*).
- **Run-of-the-River Hydroelectric Project** The Wells, Rocky Reach, and Rock Island hydroelectric projects are run-of-the-river projects, which means that they do not store substantial amounts of water in their reservoirs. Run-of-the-river hydroelectric projects produce electric power through use of the gravitational force of falling water, and consist of a powerhouse, spillway, and embankments, as well as fish passage facilities.
- Settlement Agreement Protection plans developed through negotiations with the fishery agencies and the Tribes that specify mitigation and compensation measures for the impacts to anadromous fishery resources as a result of project operations. The fish protection agreements for the Wells, Rocky Reach, and Rock Island projects are documented in the 1990 Wells Long-Term Settlement Agreement, the 1994 Fourth Revised Rocky Reach Interim Stipulation (expired), the 1987 Rock Island Settlement Agreement, and the Vernita Bar Agreement.
- * See Chapter 7 for a complete listing of all Key Terms.

This chapter summarizes alternatives to address Endangered Species Act requirements for listed species affected by operation of the Wells, Rocky Reach, and Rock Island hydroelectric projects. The three alternatives considered for the projects are discussed and compared on a general level in this chapter, and presented in more detail in

Chapter 4, Environmental Consequences. Specifically, this chapter explains:

- how the alternatives were developed,
- the existing hydroelectric projects and related fisheries issues,
- alternatives considered in this EIS,

- the common and the unique features of the alternatives,
- alternatives eliminated from detailed evaluation,

- comparative differences between the alternatives, and
- NMFS's preferred alternative and the process used in selecting this alternative.

2.1 DEVELOPMENT OF ALTERNATIVES

Upper Columbia River steelhead and spring-run chinook salmon were listed as endangered under the Endangered Species Act in 1997 and 1998, respectively. The alternatives examined in this EIS include a no-action alternative and two action alternatives and the effectiveness at minimizing and mitigating to the maximum extent practical, the incidental take of both Endangered Species Act-listed and unlisted anadromous salmon and steelhead at the Wells, Rocky Reach, and Rock Island hydroelectric projects.

Hydroelectric projects have the potential to impact steelhead and spring-run chinook salmon through the direct and indirect effects of project operations, and due to changes in habitat that result from project operations. As a result, an incidental take of either of these species may occur. An incidental take of a listed species is any take that results from, but is not the purpose of, an otherwise lawful activity. Take, as defined in Section 9 of the Endangered Species Act, is to harass, harm, pursue, hunt, shoot, wound, trap, capture, collect, or attempt to engage in any such conduct. Under the terms of Section 7(b)(4), Section 7(a)(2), and Section 10(a) of the Endangered Species Act, a take is not prohibited provided that it is in compliance with the terms and conditions of either a biological opinion (Section 7) or an incidental take permit (Section 10).

2.1.1 Section 7 Process

Section 7 of the Endangered Species Act requires that Federal agencies consult with USFWS and/or NMFS (the Services) to ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of

any Endangered Species Act-listed species or result in the destruction or adverse modification of their habitat. The result of formal consultation is typically a biological opinion that determines whether an agency action, taken together with cumulative effects, is likely to jeopardize the continued existence of the listed species, or result in the destruction or adverse modification of designated critical habitat. In addition, the Services also provide an incidental take statement for actions not violating the prohibitions set forth in Endangered Species Act Section 7(a)(2). FERC is required to consult with NMFS under Section 7 prior to amending licenses for the Wells, Rocky Reach, and Rock Island hydroelectric projects that could affect listed species.

Under this process, FERC would identify the effects on listed species that may result from the proposed action. The agency would then suggest measures to protect the species to the extent possible and describe how these measures would be implemented. NMFS would then prepare a biological opinion to determine if the proposed action and associated protection measures are sufficient to avoid jeopardizing the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat.

A "no jeopardy" biological opinion would be issued only if NMFS determines that the actions are not likely to jeopardize the continued existence of the listed species or cause the destruction or adverse modification of the habitat on which they rely, and that there is adequate potential for recovery of listed species when the proposed protection measures are implemented.

If NMFS determines that the proposed measures are not adequate to ensure the continued existence of the species, a reasonable and prudent alternative to the proposed action would be developed. The measures developed by NMFS and the terms and conditions or reasonable and prudent alternatives are mandatory requirements of a biological opinion. To be in compliance with the take prohibitions of Section 9, FERC would amend the PUDs' licenses to include the measures identified in the biological opinion. However, modification of a FERC license is subject to appeal by the licensee (the PUDs).

The reasonable and prudent measures or alternatives and the terms and conditions of the biological opinion would remain in effect as long as new information did not indicate that the species' continued existence was in jeopardy. Reinitiation of consultation is required if the amount or extent of taking specified in the incidental take statement is exceeded, new information reveals effects on listed species or critical habitat not previously considered, the action is modified in a way that causes an effect on listed species or critical habitat not previously considered, new species are listed, or critical habitat is designated.

2.1.2 Section 10 Process

Non-Federal applicants can apply for a special exemption to the take prohibitions by utilizing the Section 10 permitting process. The Section 10 process requires applicants to develop a conservation plan specifying, among other things, impacts that are likely to result from their proposed actions, and defining the measures that would be taken to minimize and mitigate for these impacts. Conservation plans under the Endangered Species Act are also known as HCPs. A biological opinion from NMFS would still be required under the Section 10 process and reviewed to determine if the incidental take of a species, considering the applicant's HCP measures, would cause jeopardy to the species or

destruction or adverse modification to designated critical habitat.

2.1.3 EIS DEVELOPMENT

This EIS examines the Federal and non-Federal alternatives for complying with the Endangered Species Act and impacts of the proposed action and other alternatives on all resources of the human and biological environment. Each alternative (including the no-action alternative) provides some level of protection for all species. However, NMFS's abilities to pursue additional protective measures differ markedly between the two action alternatives. Alternative 1 (no-action alternative) is included and evaluated to assess the impacts of compliance with existing license conditions and settlement agreements, for comparison with additional conservation measures associated with Alternatives 2 and 3.

Alternative 2 sets forth changes to project operations and facilities that could be implemented at the project in future relicensing, license reopener proceedings, or amendment proceedings. The measures analyzed in Alternative 2 include the increased use of spill at all three projects. Alternative 2 also includes the construction and operation of a sluiceway bypass system at Rocky Reach Dam to be used with, or instead of, the bypass system currently being constructed. The procedural mechanism for implementing such measures, and for obtaining Endangered Species Act authorization, differs depending on the status of the species. For Endangered Species Act-listed species, Alternative 2 primarily involves the Section 7 process, where FERC consults with NMFS prior to making a decision on proposed modifications of the project structures or operations or other plans that may affect listed species. For unlisted species, this alternative involves the use of NMFS's Federal Power Act authorities to pursue additional protective measures in future relicensing or license reopener procedures or amendment proceedings.

Alternative 3 includes the project operations and mitigation measures described in the proposed HCP applications. Endangered Species Act authorization for implementation of these measures could be accomplished through the Section 10 process for non-Federal applicants (HCP approach). This alternative would provide incidental take permits to Chelan and Douglas County PUDs for the implementation of protective measures (the HCPs) covering both listed and unlisted species (see Section 13.20 of the Rocky Reach, Rock Island and Wells HCPs.

A 50-year time period, based on the 50-year implementation period of the proposed HCPs (see Section 1.1 of the Wells, Rocky Reach, and Rock Island HCPs), is used in this EIS for comparison among the alternatives. Alternative 1 (no-action alternative) represents existing conditions and assumes that the ongoing conservation measures at each project would continue relatively

unchanged over the next 50 years. Over the course of this 50-year period, project relicensing and specific reopener clauses in the existing licenses would be used under Alternative 2 to address the ongoing effects of project operations on anadromous salmonids. Under Alternative 3, the terms and conditions of the HCPs would address the effects of project operations on anadromous salmonids over the 50-year time period.

Over this time period, possible changes to the project area include: (1) more species could be listed; (2) spring-run chinook salmon and/or steelhead could be delisted due to the overall success of the protection measures implemented by the PUDs, State and Federal agencies, and private entities, and/or improved total life-history survival conditions; or (3) listed fish populations could continue to decline or remain at or near existing population levels.

2.2 PROJECT DESCRIPTION

2.2.1 PHYSICAL FEATURES

The Wells, Rocky Reach, and Rock Island hydroelectric projects are run-of-the-river projects, which means that they do not store substantial amounts of water in their reservoirs compared to the larger storage projects like the Chief Joseph or Grand Coulee dams upstream. Each project consists of a powerhouse, spillway, and embankments. The reservoir area immediately upstream of each powerhouse and spillway is called the forebay, while the tailrace is on the downstream side of the project. The upper limit of each reservoir encroaches upon the tailrace of the next project upstream (Table 2-1).

2.2.1.1 Wells Dam

Until the early 1990s, the Wells Dam was the only dam in North America designed as a hydrocombine. While traditional dams have separate powerhouse and spillway structures, the

Wells hydrocombine integrates the two by placing the spillway openings in unused space between the generators (Figure 2-1). The dam spans 4,460 feet, with the hydrocombine structure comprising 1,130 feet (Table 2-2). Generating facilities consist of 10 Kaplan turbines, with a generating capacity of 840 megawatts. The project has a hydraulic capacity of about 205,000 cubic feet per second (cfs) through the powerhouse.

The original Kaplan turbine units were replaced with minimum gap type Kaplan turbine runners in the early 1990s. As well as being more efficient, these units are designed to reduce cavitation and decrease the gaps between the runner blades and the hub and the runner blades and the discharge ring, which have been identified as potential sources of fish injury or mortality within the turbine environment. As a result, the new units are expected to have increased juvenile fish passage survival through the powerhouse.

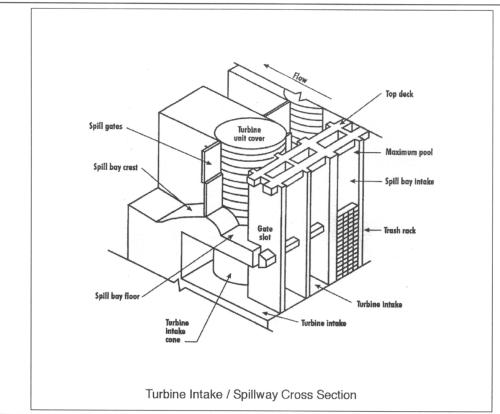
RESERVOIR FEATURES OF THREE MID-COLUMBIA RIVER HYDROPOWER PROJECTS **TABLE 2-1.**

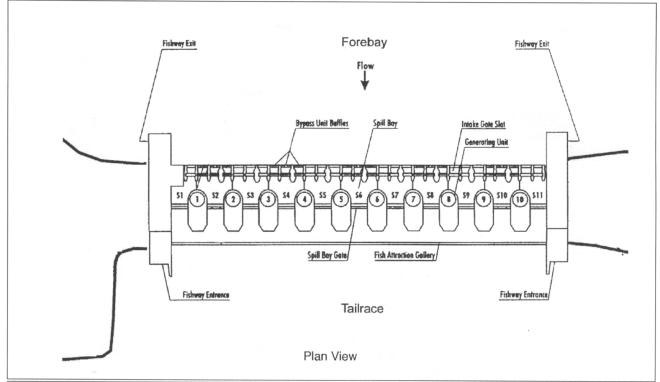
FEATURE	WELLS	ROCKY REACH	ROCK ISLAND
Reservoir common name	Lake Pateros	Lake Entiat	Rock Island
Owner	Douglas County PUD	Chelan County PUD	Chelan County PUD
Type of operation	Run-of-the-river	Run-of-the-river	Run-of-the-river
Dam location (river mile)	515.8	474.5	453.4
Upper limit of reservoir	Chief Joseph tailrace	Wells tailrace	Rocky Reach tailrace
Length (miles)	30	43	21
Miles of shoreline	100	93	43
Surface area (acres)	9,740	8,235	3,447
Useable storage (thousand acre-feet)	> 98	36.4	< 12.5
Total storage (thousand acre-feet)	331.2	387.5	130.0
Normal full pool elevation (feet)	781	707	613
Normal low pool elevation (feet)	177	703	609
Operating fluctuation (feet)	10	4	4
Maximum pool elevation (feet)	791	710	613
Minimum pool elevation (feet)	767	703	609
Annual median flow (thousand cubic feet per second [kcfs])	109	110.5	115

STRUCTURAL FEATURES OF THE THREE MID-COLUMBIA RIVER PUD PROJECTS **TABLE 2-2.**

FEATURE	WELLS	ROCKY REACH	ROCK ISLAND
Generating Facilities			
Total (peak) generating capacity (megawatts)	840	1,278	624
Dam configuration	Hydrocombine	Conventional	Conventional
Length (feet)			
-Left embankment	1,027	120	590
-Right embankment	2,300	460	-
-Powerhouse 1	1,130	1,088	870
-Powerhouse 2	-	-	470
-Spillway	(see Note 1)	740	1,184
Turbine Quantity	10	11	18
Turbine Type	Kaplan	Kaplan	Fixed-blade prop. (4)
	·	(see Note 2)	Kaplan (6)
Caill gate quantity	11	12	Bulb (8) 31
Spill gate quantity		Tainter	
Spill gate type	Leaf (2 each) 75	rainter 57	Leaf (2 or 3 each gate)
Water depth at spill gate (feet)	75 Yes	57 Yes	32-57 (see Note 3) No
Spillway energy dissipaters	res 2	None	None
Sluice gates Height of sluice freefall (feet)	70	None -	None -
Fish Passage and Protection Facilities			
Fishladders	2	1	3
Adult collection channel	Yes	Yes	Yes
Adult counting stations	Yes	Yes	Yes
Juvenile bypass facilities	Yes	(see Note 4)	(see Note 5)
Tailrace predator control wiring	Yes	Yes	Yes
Fish Production Facilities			
Associated hatcheries	Wells	Chelan	Eastbank
	Methow	Rocky Reach	

- 1. The spillway of Wells' hydrocombine is located vertically above the turbine intakes.
- 2. Rocky Reach turbines currently in the process of being replaced.
- Rock Island has a range of spillway crest elevations.
 Permanent surface collection bypass facility is being installed in 2002.
 Gatewell orifice and collection channel at Powerhouse 2.





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Figure 2-1 Prominent Features of Wells Dam

The hydrocombine structure contains 11 spill bays. The spillways at Wells are located on top of the turbine intakes and are interspersed between the turbine unit silos. Each spill bay is 46 feet wide and over 70 feet deep. The peak spillway flood capacity at Wells Dam is 1,180,000 cfs. The total hydraulic capacity of Wells Dam is 1,385,000 cfs.

The adult fish passage facilities at Wells Dam consist of identical but mirror-image left and right bank fishway facilities. Each fishway is a conventional pool and weir fishladder.

2.2.1.2 Rocky Reach Dam

The Rocky Reach Dam is a traditional hydroelectric project with separate powerhouse and spillway structures (Figure 2-2). The dam spans 2,460 feet, with the powerhouse comprising 1,088 feet and the spillway comprising 740 feet. There are 11 turbines at Rocky Reach Dam, providing the total nameplate generating capacity of about 1,280 megawatts (encroached) and a total hydraulic capacity of 217,500 cubic feet per second (cfs). Units 1 through 7 are currently vertical shaft Kaplan turbines installed during the original construction in 1962, while fixed-blade propeller turbines were installed at Units 8 through 11 in 1971.

Several of these fixed-blade propeller units have been rehabilitated and replaced with Kaplan turbines, with the rehabilitation of the remaining units expected to be completed in 2003. In addition, all but one of the original Kaplan units have been rehabilitated and replaced with more efficient Kaplan turbines. As well as being more efficient, these units are designed to reduce the gaps between the runner blades and the hub, which have been identified as a potential source of fish injury or mortality within the turbine environment. As a result, these replacement units are expected to increase juvenile fish passage survival through the powerhouse.

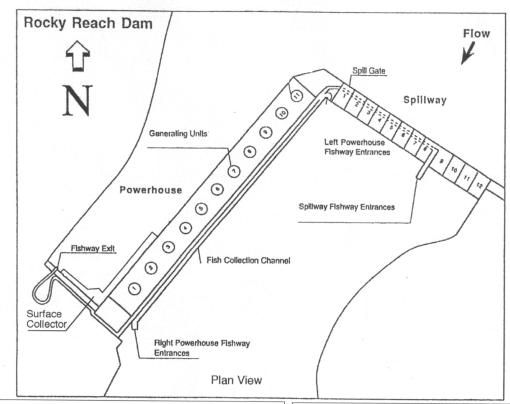
The spillway structure at Rocky Reach Dam contains 12 spill bays. Each spill bay is 50 feet wide. The Rocky Reach Dam is equipped with a single adult fishway system.

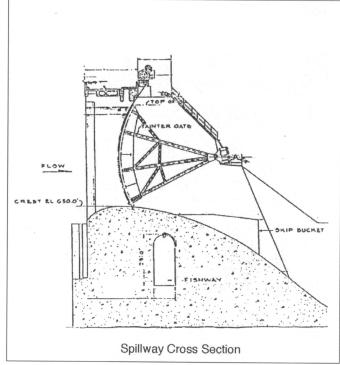
There are four general areas where upstream migrating fish can enter the adult fishway system: at the right end of the powerhouse, at the left end of the powerhouse, at the spillway fishway entrance, and at the powerhouse fish collection channel.

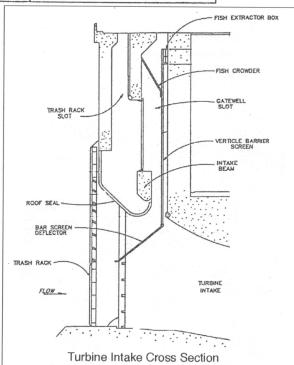
2.2.1.3 Rock Island Dam

The basic configuration of Rock Island Dam is that of a traditional hydroelectric project with separate powerhouse and spillway structures. However, Rock Island Dam is somewhat atypical in that there are two powerhouses, one each at the left and right banks (Figure 2-3). The dam spans a total of 3,115 feet, with Powerhouse 1 comprising 871 feet, Powerhouse 2 comprising 470 feet, the spillway comprising 1,185 feet, and the left abutment wall comprising 590 feet. The spillways were built to generally follow the existing topography, so spill bays built in deeper sections of the river are taller (deep spill bays), while those in shallower channel section have smaller (shallow) gates (see Figure 2-3).

There are currently 18 turbine units and one station service unit at Rock Island Dam, providing a total nameplate generating capacity of 624 megawatts (encroached) and a total hydraulic capacity of 220,000 cfs. The original construction in the 1930s installed Nagler turbines in Units 1 to 4 of Powerhouse 1. The second class of turbines at Rock Island Dam consists of Kaplan turbines. These units were installed as Units 5 through 10 in Powerhouse 1, coming online during the period from 1952 to 1953. The third class of turbines at Rock Island Dam consists of bulb turbines. Eight bulb turbines were installed as part of the Powerhouse 2 construction project, coming on line in 1979.

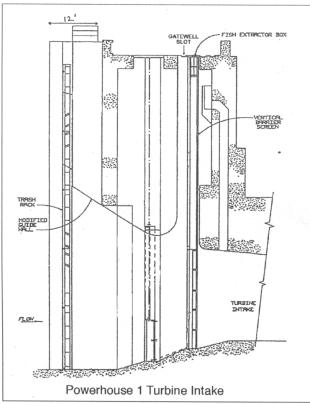


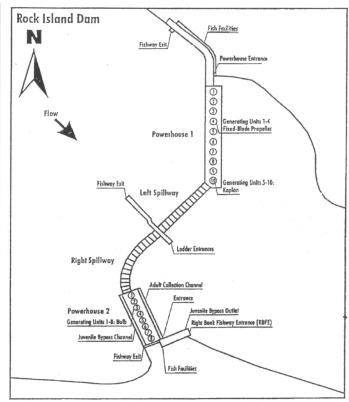


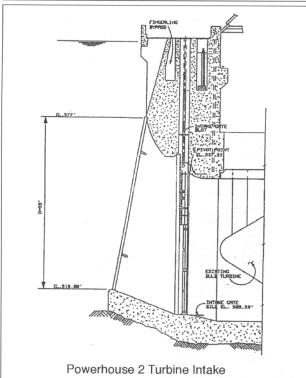


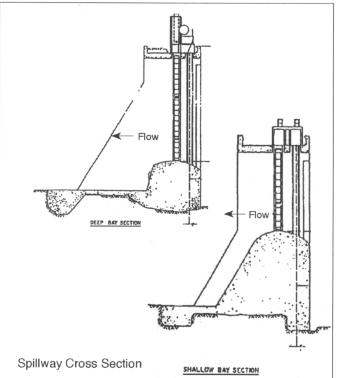
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Figure 2-2 Prominent Features of Rocky Reach Dam









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Figure 2-3 Prominent Features of Rock Island Dam

Upstream passage facilities at Rock Island Dam are composed of three conventional pool and weir fishladders.

2.2.2 DAM AND RESERVOIR OPERATIONS

The three mainstem Mid-Columbia River projects reviewed in this EIS were built to produce power. Collectively, the three dams generate over 14 billion kilowatt-hours annually, or nearly 6 percent of the entire hydropower output in the United States. Operation of these projects, however, must also take into account the diverse interests of a broad spectrum of agencies and river users.

In general, the three dams are operated to meet instantaneous demands for power. The projects produce varying amounts of power throughout a typical 24-hour period, with typical daytime peaks being about 135 percent of the nighttime power production. With lower demands for power, hydropower projects use fewer turbines and discharge less water. When more power is needed, hydropower projects use more turbines and discharge more water.

The number of turbines in use changes the most during the early morning and late evening hours. In most cases, there are more turbines in operation during the day than at night, which means that more water passes the dams during daytime. Since the Mid-Columbia River projects do not store large amounts of water, their ability to generate power depends to a large degree on upstream storage projects. Flow releases from upstream Federal dams (Grande Coulee and Chief Joseph dams) are timed to meet daytime load demands at the downstream dams throughout the day.

The operators of Columbia River hydropower projects coordinate project operations to ensure the best use of the available water and the most efficient generation of power to meet demand. Upstream projects pick up more of the load in the morning, and downstream projects use this pulse

of flow to generate electricity in the afternoon and evening. This coordination maximizes generation efficiency at the plants by minimizing reservoir drafting and maintaining efficient "operating heads" for the turbines.

As a general rule, the PUDs operate their turbines at the highest power efficiency possible for a given flow to maximize power generation and revenue for the facility and to maximize the operating life of the turbine units. Operating the units at or near the peak efficiency reduces the turbulence and cavitation of water passing through the unit, resulting in more efficient generation conditions. Reduced turbulence and cavitation improves the flow conditions for fish passing through the turbines, and is expected to result in reduced injury and mortality rates.

Each turbine unit receives approximately the same amount of wear and tear through alternating turbine use. This process is relatively straightforward at Wells Dam, which has 10 turbines of similar type and performance characteristics. Rock Island and Rocky Reach dams use several types of turbines, and the Chelan County PUD decides which turbines to use by considering how much water will be discharged and how efficiently each turbine will meet power demands. Turbine unit priorities may also reflect fish passage needs or other reasons not related to power generation.

Water discharged over spillways, rather than through turbines, is unavailable for power production at that facility. Generally, dam operators prefer to minimize the amount of water they discharge through the spillway. Forced spill is necessary when more water is entering the reservoir than the powerhouses can discharge. Because the dam operators along the Columbia River now coordinate their operations, the amount of forced spill has dropped significantly. When forced spill does occur, it typically is at night when energy demand is lowest, or during a period of high run-off.

At each of the mainstem PUD projects, some or all of the spill gates have dedicated automatic hoists to accommodate sudden storm, flood, or load rejection events in accordance with FERC requirements. The remaining spill gates are opened and closed using gantry cranes that serve more than one spill gate and are used to perform other maintenance duties. It is generally preferred to conduct spill through hoist-equipped gates, so that the gantry cranes remain available for other uses. Ice and floating debris that accumulates in the forebay are usually removed with a crane. In extreme circumstances, floating material can be removed by passing it through sluice gates located at the reservoir surface level. Since the sluice gates at these projects are much smaller than the spill gates, they may also be used during forced spill events when the discharge volumes are small.

2.2.3 How the Dams Affect Migrating Fish

The dams on the Columbia River affect migration speed and the timing of both juvenile and adult salmon and steelhead movements. Juveniles can be killed, injured, or disoriented when they pass downstream through dams.

The major juvenile fish passage routes are:

- through a turbine;
- over a spillway or through a sluiceway;
- through a juvenile fish bypass system; or
- through ancillary dam facilities, such as the adult fishway facilities.

Direct or indirect effects to fish can result from any of these project passage routes. Direct effects are a consequence of physical injuries that may be incurred during passage, resulting in immediate or delayed mortality. Indirect effects result from debilitated, disoriented, or stunned fish being exposed to additional sources of mortality, such as predation (Chapman et al. 1994a). Adults migrating upstream can also be impacted. Although under normal conditions it is likely that few adults are directly killed when they travel upstream past the dams, each dam can potentially delay fish at fishways (fishladders). Delays in fish passage may require fish to expend more energy to pass or increase their exposure to high concentrations of dissolved gases caused by spilling water at the dams. However, adult salmonids typically travel through the reservoirs at a faster rate than through natural river channels. As a result, delays caused by dam passage are likely offset by the faster reservoir travel rates.

The adult salmon and steelhead may also fall back through the dam, resulting in increased delays and potential injury. Additionally, a percentage of adults fail to enter project fishways and pass upstream. Even with the latest fish tagging technologies, in many instances it is still not possible to determine if the failure of fish to pass a project is due to specific problems with the fishladders. This is because some of the tagged fish detected at a project may actually be returning to downstream hatcheries or a natural spawning area.

Over the past several decades, many scientific studies have focused on the effects of the Columbia River system hydropower projects on anadromous fish. Some of the studies have focused specifically on the three Mid-Columbia River projects, while others have focused on the overall system, on other projects, or on particular effects. These studies have helped determine the ways hydropower projects impact fish, and they have shaped the actions needed to reduce impacts. However, the available studies do not always provide definitive assessments of the full range and magnitude of project impacts because different methods, timeframes, and locations were used.

2.2.3.1 Juvenile Passage

Juvenile salmon and steelhead pass the three Mid-Columbia River PUD dams through turbines or

spillways, or through juvenile collection or bypass systems. Juveniles may be killed or harmed by any of these dam passage routes, but the highest levels of mortality typically occur when fish pass through turbines (Whitney et al. 1997). In an effort to increase survival, the project operators use bypass systems and spill during the juvenile migration period.

The three Mid-Columbia River PUD project operators intend that the majority of smolts pass

the dams through bypasses or by spill, thereby avoiding passage through turbines. This objective is measured through an assessment of fish passage efficiency, an important indicator of project effects. The proportion of fish passing through spillways and bypasses is an important element in the calculation of dam passage survival for juvenile salmon and steelhead. Current project operations for enhancing juvenile passage are provided in Table 2-3. These are the conditions that define Alternative 1.

Table 2-3. Summary of Existing Juvenile Fish Bypass Systems and Spill Operations at Wells, Rocky Reach, and Rock Island Dams (Alternative 1)

PROJECT	BYPASS SYSTEM	PERIOD OF OPERATION			
Bypass Systems/Operations					
Wells	Surface bypass (baffled spill gates with discharge through controlled spill of up to 11% of total river discharge)	The Wells bypass team determines the timing of bypass operations of the bypass to cover at least 80% of the spring and summer juvenile anadromous fish migration timing. Fyke netting and hydroacoustics are used to help the bypass team make operational decisions regarding use of the bypass system.			
Rocky Reach	Turbine screens in two units; prototype surface bypass (discharge through conduit to tailrace	24 hours/day between April and August. Construct a permanent bypass system ¹ before the 2003 migration and continue to evaluate and improve the efficiency of the bypass, and provide spill as an interim measure (see below)			
Rock Island	Passive gatewell orifice bypass system at Powerhouse 2 (discharges through a conduit to tailrace)	24 hours/day (spill is the primary bypass system used at Rock Island as described below)			
Spill Operations	,				
Wells	See bypass operations (above)	See bypass operations (above)			
Rocky Reach	15% of previous daily average flow in spring	30 days during spring migration, plus up to 6 extra days if necessary to encompass 90% of the run of Okanogan River sockeye			
	10% of previous daily average flow in summer	Total of 34 days between June 15 and August 15			
Rock Island	Spring and summer spill purchased by joint request of the Fisheries Agencies and Tribes from a Fisheries Conservation Account of \$2.05 million (1986 dollars adjusted for inflation) at the market price of energy	The Fisheries Agencies and Tribes decide when and how much spill to purchase based on funds available in the Fisheries Conservation Account			

The construction and operation of the permanent bypass system has been consulted on by NMFS and authorized by FERC. However, because this system has been developed as a major component of the HCP, the effect of the new bypass structure is analyzed in the HCP alternative (alternative 3) rather than in the no-action alternative.

Juvenile Passage Through Turbines

Juveniles passing through turbines can be killed or injured by mechanical, pressure, or hydraulicrelated factors. The turbine blades may strike fish, and fish can be injured passing through gaps between turbine components. Recent advances in turbine design attempt to minimize gaps between components to reduce the potential injury rates to fish. Fish may be killed by pressure or hydraulic conditions, such as when fish pass through areas of cavitation (vacuums) or hydraulic shear, as well as pressure or velocity changes. It is generally believed that operating turbine units at or near peak power efficiency reduces these potentially injurious hydraulic conditions for fish, although the exact benefits to fish survival are unknown (NMFS 2000d).

Indirect mortality occurs after fish have left the turbine. The principal cause of indirect mortality of juvenile fish is generally believed to be from predation by fish or birds. This most likely occurs in the immediate tailrace area as the juveniles recover from the disorientation and stress of turbine passage (Ledgerwood et al. 1990). Stress may also weaken the resistance to disease and cause subsequent delayed mortality (Ferguson 1994).

There have been many turbine survival studies conducted with juvenile salmon and steelhead at the Snake, Lower Columbia River, and Mid-Columbia River dams. The resulting turbine survival estimates have varied greatly, ranging from 87.7 to 81 percent (Whitney et al. 1997). When survival has been estimated through the recovery of fish immediately after passing through turbines, the survival rates were typically greater than 93 percent (average 94.5 percent). In studies with longer times between turbine passage and recovery, survival levels averaged 89.1 percent (Whitney et al. 1997). This suggests that the higher mortality estimates include delayed mortality and the potential indirect mortality effects of predation on disoriented smolts, as well as direct mortality from turbine passage.

Some recent studies indicate that the highest estimates of direct juvenile survival peak when turbines are operated above 1 percent peak efficiency. Yet others indicate that this operation may result in lower survival estimates. Because of these mixed results, NMFS generally presumes, in the absence of specific data, that the

best fish passage conditions occur when turbines are operating within 1 percent of peak efficiency. NMFS passive integrated transponder (PIT)-tag studies of turbine survival over a wide range of turbine operating efficiencies in the Snake River estimated survival at 92.0, 86.5, 92.7, and 93.4 percent in 1993, 1994, 1995, and 1997, respectively (Muir et al. 2001). NMFS's analysis conducted in support of the FCRPS biological opinion indicate that juvenile survival through turbines at Columbia and Snake River main stem hydroelectric projects generally range between 90 and 93 percent.

Wells Dam

The survival estimates developed as a result of the PIT-tag evaluations conducted in 1998, 1999, and 2000 represent the best available information regarding both the direct and indirect effects of the Wells Project on the survival of juvenile Upper Columbia River spring-run chinook salmon and steelhead (Table 2-4). These studies indicate that project survival for yearling chinook is 99.7 percent (1998), and for steelhead studied in 1999 and 2000 survival averaged 94.2 and 94.6 percent, respectively (Bickford et al. 2000a, 2000b, 2001). The three-year average project survival estimate for yearling spring-migrating chinook and steelhead is 96.2 percent.

Approximately 8 percent of the yearling steelhead and spring-run chinook salmon and 4 percent of subyearling chinook salmon outmigrants pass through the turbines at the Wells Dam (Skalski 1993). Based on the information discussed above, the best current estimate of smolt survival for passage through turbines that includes both the direct and indirect components of mortality is 90 to 93 percent. Overall juvenile dam passage survival can be calculated by using this turbine survival estimate and an estimate of spillway survival, along with the proportion of fish that pass the project through these routes. These estimates of dam passage survival do not include indirect and delayed mortality components related to fish passing through the reservoir and the dam.

TABLE 2-4. CURRENT PASSAGE TIMES AND FALLBACK OF ADULT SALMON AND STEELHEAD, AS WELL AS JUVENILE PASSAGE AND SURVIVAL RATES, PASSING THREE MID-COLUMBIA RIVER DAMS¹

	WELLS	ROCKY REACH	ROCK ISLAND
Adult Passage			
Median Project Passage Time (hours)			
Adult Spring-run Chinook	26.8-28.5	31-37	20-39
Steelhead	12	12.7	4
Summer Chinook	33-47	23-30	15
Fall Chinook	31-46	60	19
Sockeye	5-21	36	17
Fallback (%)			
Adult Spring-run Chinook	3.6	0	2.5
Summer Chinook	5	2-4	2-3
Steelhead	6-7	10.2	7.4
Sockeye	4	14	2-4
Juvenile Dam Passage			
Turbine Passage Rate (%)	4-8	79-88	75-84
Spillway Passage Rate (%)	NA	12-22	17-25
Bypass Passage Rate (%)	92-96	NA ³	NA
Turbine Survival Rate (%)	90-93	90-93	90-93 (Powerhouse 1) 90-93.5 (Powerhouse 2)
Spillway Survival Rate (%)	98-99	98-99	98-99
Bypass Survival Rate (%)	98-99	97-98	NA
Estimate of Calculated Total Juvenile Dam Passage Survival Rate (%)	96-97	91-94	91-95
Measured Project Survival of Yearling Anadromous Salmonids	94-100	86-97	89-96

Based on the best available data.

Sources: Adult Passage: Stuehrenberg et al. 1995; Swan et al. 1994; Alexander et al. 1998; English et al. 1998a, b, 2001 Juvenile Passage: Whitney et al. 1997; Skalski 1993; Bickford et al. 1999, 2000a, 2000b, 2001; Eppard et al. 1998; Stevenson et al. 2000.

Therefore, results from project-specific survival studies represent the best available data.

Rocky Reach Dam

Two studies of direct mortality on juvenile passage through the Kaplan turbines at the Rocky Reach Dam found passage survival to be 94 percent in 1993 (RMC Environmental Services and Skalski 1994), and 95 and 96 percent in 1996 (Normandeau Associates and Skalski 1996).

Considering both direct and indirect mortality, turbine survival rates ranging from 90 to 93 percent are also assumed to represent overall turbine passage survival for all species at the Rocky Reach Dam, with peak turbine power efficiency operations. The PUD has begun a multi-year process to install new turbines that are designed to reduce the gap between the blade and runner, which is one cause of direct mortality

NA = Not available.

³ The bypass that is currently being constructed it is specifically linked to the HCP. Therefore, for comparison purposes the prototype passage results were not included and are therefore not considered as existing conditions.

from turbines. The new turbines are also more efficient and will allow for greater flexibility in distributing powerhouse load among different turbines.

The survival estimates developed as a result of the passive integrated transponder (PIT)-tag evaluations conducted in 1998, 1999, and 2000 represent the best available information regarding both the direct and indirect effects of the Rocky Reach Hydroelectric Project on the survival of juvenile Upper Columbia River spring-run chinook salmon and steelhead (see Table 2-4). These studies indicate that juvenile spring-run chinook salmon survival was 85.9 percent based on total project survival evaluations conducted on hatchery-reared yearling fall chinook salmon in 1998 (Eppard et al. 1999). The weighted average project passage survival estimates for Upper Columbia River hatchery steelhead in 1999 and 2000 were 95.9 and 96.7 percent, respectively (Bickford et al. 2000a, 2000b, 2001). However, the 1999 and 2000 survival estimates were based on a single release-recapture model, and therefore do not include all of the mortality associated with passage via turbines or the spillway or in the tailrace of Rocky Reach Dam (see discussion in Section 4.2.1.1, Endangered Anadromous Salmonid Species). Thus, survival estimates based on the single release-recapture model are likely biased high compared to estimates made by a paired release survival study.

Rock Island Dam

Rock Island Dam has three different types of generating units. The first powerhouse contains a total of 10 vertical axis turbines that include four Nagler fixed-blade units and six Kaplan-type adjustable blade units. The second powerhouse contains a total of eight horizontal-axis bulb turbines. A study of Rock Island Dam has shown that the bulb and Kaplan turbines have a higher survival rate than the Nagler turbines. Fall chinook salmon passing through the Kaplan units had estimated direct survival rates of 96.1 and 95.7 percent, while fish passing the Nagler units showed a 93.2 percent survival rate (Normandeau

Associates and Skalski 1997). However, this estimate does not include indirect and delayed mortality effects. Therefore, as with Wells and Rocky Reach dams, the 90 to 93 percent survival rate that includes both direct and indirect causes of mortality is assumed to represent turbine passage survival for all species at the Rock Island Dam.

The survival estimates developed as a result of the PIT-tag evaluations conducted between 1998 and 2001 represent the best available information regarding both the direct and indirect effects of the Rock Island hydroelectric project on the survival of juvenile chinook salmon and steelhead (see Table 2-4). These studies indicate that juvenile Upper Columbia River spring-run chinook salmon survival is 88.9 percent, based on total project survival evaluations conducted on hatchery-reared yearling fall chinook salmon in 1998 (Eppard et al. 1999), and juvenile Upper Columbia River steelhead survival is 95.8 percent based on total project survival evaluations conducted on hatchery-reared juvenile steelhead in 1999 (Stevenson et al. 2000).

PIT-tag evaluations in 2000 and 2001 using hatchery fall chinook salmon resulted in weighted average project survival estimates of 91.8 percent and 92.2 percent, respectively (Skalski et al. 2000, 2001). Direct juvenile salmonid survival estimates calculated at the spillway and powerhouses, although not conclusive, are consistent with the trends identified in the PIT-tag survival evaluations.

<u>Juvenile Passage Through Bypass</u> <u>Systems</u>

Fish bypass systems can be fairly complex systems that can include turbine intake screens, gatewell orifices, bypass flumes, dewatering screens, sampling facilities (including holding tanks), and bypass outfall conduits. These features vary by project, and all of them affect the survival rate of juvenile salmon and steelhead. Studies of bypass systems at the Snake and

Lower Columbia River projects suggest that mortality of wild steelhead and yearling chinook is generally less than 1 percent (Martinson et al. 1997; Spurgeon et al. 1997; summarized in the 2000 NMFS Federal Columbia River Power System biological opinion [NMFS 2000a]). However, mortality rates vary by species and the size of fish due to factors such as propensity for scale loss and impingement on the screens (NMFS 1995). Therefore, a conservative estimate of mortality (1 to 2 percent) is assumed for the Mid-Columbia River projects.

These figures do not include the level of mortality due to predation at the outfall, which requires further investigation (Ferguson 1994). Predation has been found to increase when outfall sites are poorly located or when juvenile salmon and steelhead are concentrated into a comparatively small volume of water. Juveniles also may be injured in the bypass system and then later succumb to predators.

When most Columbia River system dams were constructed, juvenile fish could pass only over the spillways or through turbines. As the number of mainstem dams on the Columbia and Snake Rivers increased, the cumulative impacts on downstream migrating fish were recognized as a significant fisheries management problem. In the early 1950s, the U.S. Army Corps of Engineers started the Fish Passage Development and Evaluation Program to develop methods of safe juvenile fish passage at the mainstem dams (BPA et al. 1994a). Other entities have cooperated with this program and contributed additional research efforts, including USFWS; NMFS; State, Tribal, and Canadian resource agencies; and many public and private industrial concerns.

Juvenile dam passage is still considered to be the primary cause of salmon and steelhead mortality at hydroelectric projects, and is the primary area in which survival improvements are proposed to occur. The typical bypass system features can be divided into four groups: behavioral barriers,

physical barriers, fish-diversion devices, and fishcollection devices.

Behavioral barriers attempt to move fish away from an area of concern by using measures that repel fish but do not physically block them. Examples are electrical screens, air bubbles, lights of various types, and sound barriers. These barriers allow water to pass freely, and avoid the problems of debris accumulation. They do not lower turbine power efficiency, and they do not cause physical injuries to fish. However, there has been limited success with these measures under conditions experienced at large mainstem dams (Stone and Webster 1986).

Physical barriers and diversion devices are the most common bypass measures on the Columbia and Snake River dams. These two measures prevent fish from entering turbine intakes and provide an alternative passage route around the project. To be effective, the system must be designed to allow fish to locate and use the bypass entrance. Although the design parameters for physical barriers are based primarily on the swimming abilities and physical size of the fish, their effectiveness largely depends on fish behavior and conditions at the particular dam, which may vary considerably.

Nearly all physical barriers at mainstem Columbia Basin dams involve a fish screen mechanism. As a result of years of investigative studies and evaluations of full-scale applications, NMFS has developed fish screen criteria to enhance the performance of these facilities (NMFS 1994b). Fish swimming ability is a primary consideration in these criteria. Swimming ability can be estimated according to the species and size of fish, but swimming ability varies according to factors such as the duration of swimming time required, the level of dissolved oxygen, water temperature, light conditions, the physical condition of the fish, and the migrational life stage.

Juvenile screening facilities have been added as a retrofit to turbine intakes at many dams. In many cases, it was not possible to fully screen turbine intakes because of constraints within the existing powerhouse structures, excessive water velocities, and conflicts with intended project operations. Partial screening systems are more common, and they reduce but do not eliminate turbine passage. The fish screens installed at typical projects intercept approximately the upper third of the turbine intake flow (DeHart 1993).

Fish screens for turbines do affect flow conditions, and may result in reduced turbine power efficiency and greater pressure drops across the turbine runners. The presence of fish screens may also move fish to lower portions of the water column. While fish screens should significantly reduce the number of fish passing through turbines, the mortality rate for fish through the turbines may be higher as a result of their altered depth distribution entering the intake (BPA et al. 1994b).

Fish screens can result in substantial mortality or injury to juvenile fish, particularly small fish. Gilbreath et al. (1993) reported a 20 percent direct and indirect mortality of subyearling chinook at the Bonneville Dam second powerhouse screen bypass system. However, subsequent evaluations of the modified system showed mortality rates of 2 percent or less for steelhead and yearling and subyearling fish (Gilbreath and Prentice 1999). Screen bypass systems have also been shown to result in high descaling rates for sockeye and impingement rates for lamprey.

The fish screen barriers at the projects divert fish into gatewells located above the turbine intakes. The gatewells were originally designed for turbine operation and maintenance, but many have been modified for juvenile bypass. The most common approach is to install orifices that lead to a collection channel inside the dam. The orifices provide a route for the bypassed fish to volitionally exit the gatewell to reach the collection channel and bypass route. The

collection channel runs the length of the powerhouse, then changes to either a pipeline or open flume that carries fish to the release site below the project.

NMFS has developed bypass facility criteria with the objective of expediting fish passage with minimal injury (NMFS 1994b). Criteria cover aspects of the bypass layout, entrance conditions, conduit design, and outfall conditions. While some of these criteria are based upon the swimming ability of the juvenile fish, others are concerned with juvenile behavioral responses to hydraulic conditions at the barrier and through the bypass facilities. Hydraulic conditions vary considerably from site to site and also change in response to seasonal flows. As a result, the design of bypass facilities is not a generic process and is very much dependent on the collection of site-specific hydraulic and biological data.

Additional research efforts are focusing on surface collector bypass systems owing largely to the success of the Wells Dam bypass system completed in 1989. Since juvenile anadromous fish tend to migrate in the upper portion of a reservoir, surface collector systems attempt to provide attraction flow higher in the water column than the attraction flow being created by the turbines. The Wells Dam system includes vertical baffle slots to create attraction flow into the spillway bypass, while other prototype systems are examining shallow skimmer weirs and orifices similar to the sluiceways at the Ice Harbor and The Dalles dams (BPA et al. 1994b).

Wells Dam

Hydroacoustic studies conducted from 1990 through 1992 at the Wells Dam estimated that 92 percent of the spring migrants, which include both steelhead and spring-run chinook salmon, were guided through the juvenile bypass system (Skalski 1993). These estimates have been supported by similar information collected during concurrent fyke net evaluations (Bickford 1997). A juvenile chinook balloon-tag study that was conducted in 1993 concluded that there was no

measurable direct injury or mortality through the bypass system (RMC Environmental Services 1993). Although this study did not measure the effects of predation in the tailrace, bypassed fish are not concentrated at one location (as in the case of a typical bypass outfall), and the spillway flow only falls an average of 5 feet before becoming mixed back into the turbine discharge. These attributes may reduce the effects of predation in the tailrace. Therefore, the total direct and indirect mortality is likely less than the 2 percent found at the Lower Snake River project screen bypass and collection systems (NMFS 1998a).

The PUD operates the bypass system to provide passage for at least 80 percent of the juvenile spring and summer migrants to pass the Wells Dam. In 1999, the bypass was operated during 98.2 percent of the migration period (Wells Coordinating Committee, unpublished data). The Wells Coordinating Committee bypass team determines the operation dates for the Wells bypass system by utilizing monitoring information from hydroacoustic transducers installed in the forebay of the Wells Dam.

Rocky Reach Dam

A prototype juvenile bypass system was constructed at Rocky Reach Dam in 1994. Modifications and subsequent evaluations of the prototype bypass have been ongoing. Passage efficiency tests indicate that 26 to 39 percent of radio-tagged yearling chinook salmon and 47 to 57 percent of radio-tagged steelhead pass the project through the bypass (English et al. 1998a, 1999, 2000; Lady et al. 2000). Similar results were estimated using PIT-tagged fish, with 22 to 51 percent of yearling chinook salmon and 27 to 61 percent of steelhead passing through the bypass in 1998 through 2000 (Mosey et al. 1999, 2000). The bypass efficiency for sockeye salmon and subvearling chinook tended to be lower, at 27 to 39 percent and 7 to 29 percent, respectively, for PIT-tagged fish (Mosey et al. 1999, 2000; Murphy et al. 2001).

The prototype bypass system has been removed and a new bypass is currently being constructed at Rocky Reach Dam. The new bypass system includes surface collection entrances and intake guidance screens in turbine units 1 and 2. With improved hydraulic conditions at the intake screens, and with a properly sited bypass outfall, survival through the new Rocky Reach bypass system is expected to equal or exceed the 98 percent survival rate estimated for bypass systems at the Lower Snake River dams. Because the juvenile bypass system is considered a major component of the HCP it is not assumed to be an integral part of existing conditions (Alternative 1). The evaluation of the bypass system and additional measures that can be implemented if the system does not achieve HCP survival standards are addressed in Alternative 3. Therefore, the bypass system is evaluated in Alternative 3 rather than Alternative 1 (noaction).

In addition to the juvenile bypass system currently being constructed at the project, Chelan County PUD has investigated the potential for installing a sluiceway at the downstream end of the forebay cul-de-sac. Various configurations of the sluiceway concept have been modeled by Chelan County PUD during their evaluation of fish bypass options at the project. Although the juvenile bypass system was selected over the sluiceway as the preferred option as part of the HCP, the sluiceway concept is one option analyzed under Alternative 2.

Rock Island Dam

Powerhouse 2 is equipped with a passive bypass system (no intake screens for guidance) that allows fish to voluntarily enter turbine unit gatewells and exit via bypass orifices to a collection channel that leads to a fish sorting collection raceway or tailrace. The annual passage of juvenile spring-run chinook salmon through this system has ranged from 8,500 to 33,500 from 1985 to 1996 (Fish Passage Center, Annual Reports 1985 – 1996). Although the percentage of the total population is small, this

facility provides useful monitoring information about downstream juvenile migrants. Currently, Powerhouse 1 has no juvenile fish bypass system. Various turbine intake screens have been investigated at Rock Island in the late 1980s and early 1990s. The Rock Island Coordinating Committee decided not to pursue screened bypasses based on feasibility evaluations, and opted to use spill as the primary means of increasing non-turbine fish passage.

Juvenile Passage Through Spill

Fish passage spill occurs only during the juvenile migration season, generally from April through August. Spring spill (April through June) targets spring migrants (stream-type chinook, sockeye, and steelhead), and summer spill (July through August) targets ocean-type chinook juveniles (Columbia Basin Fish and Wildlife Authority 1995). Spill passage reduces the number of juveniles that pass through the turbines and is an easy and flexible system to implement. However, juveniles passing over the spillway face several risks. First, although rare at the spillway, the juveniles can sustain physical injuries, such as descaling, that may incapacitate or even kill them. Second, increasing spill may result in higher total dissolved gas levels downstream, which in turn, may cause gas bubble disease and reduce the survival rates of juvenile and adult anadromous salmonids. Juveniles that become injured or disoriented while passing over the spillway are also more susceptible to predation.

Based on past studies, juveniles that pass through spill most likely have mortality rates that range from 0 to 2 percent (Anderson et al. 1993). However, local conditions, such as back eddies or other factors, may favor predators and cause higher rates of mortality (Whitney et al. 1997). Relative to other means of passage currently available, spillways are considered the most benign routes for juveniles to pass the Mid-Columbia River projects (Chapman et al. 1994a,b).

Wells Dam

Five of eleven spill bays at the Wells Dam have been modified to function as a juvenile bypass system. This system uses baffles to increase water velocities that attract surface-oriented fish, which are then bypassed through the spillway (see previous section: Juvenile Passage Through Bypass Systems – Wells Dam).

Rocky Reach Dam

According to the Fourth Revised Interim Stipulation Agreement for Rocky Reach Dam, Chelan County PUD provides up to 30 days of spill during the spring outmigrations, at a spill level of 15 percent of the daily average river flow over a 24-hour period, with an additional 6 days of spill if necessary to encompass 90 percent of the Okanogan River sockeye run. Chelan County PUD also provides 34 days of spill during the summer migration period (June 15 to August 15). The spill level during this period is set at 10 percent of the daily average river flow.

Pursuant to the staggered effective date of the HCPs, Chelan County PUD has also voluntarily modified its spill program to benefit other Plan species. Chelan County PUD provides a spill level equivalent to 15 percent of the daily estimated flow during a period coinciding with 95 percent of the spring-run chinook salmon and steelhead spring outmigration season (typically April 20 to June 15). This also includes a 15 percent spill level during the summer migration period of subyearling chinook salmon (typically July 1 to August 15). Spill will be increased to 25 percent of the daily flow during the period coinciding with the peak of the spring outmigration of juvenile Okanogan River sockeye salmon (up to 21 days). However, if the HCP is not approved, the spill program would likely revert to the spill program implemented prior to 2002.

Studies at the dam have shown that between 8 and 19 percent of the spring migrating smolts pass through the spillway at the 15 percent spill level, resulting in spill effectiveness of between

0.5:1 and 1.2:1 (Steig et al. 1997; Chelan County PUD 2000). The estimated spill effectiveness for sockeye, coho, and subyearling chinook salmon ranged between 0.2:1 and 1.5:1 in 1997 and 1998 (Chelan County PUD 2000 unpublished data).

Only one survival evaluation has been conducted at the Rocky Reach spillway. Juvenile codedwire tagged coho salmon, released at one spill bay in 1980, resulted in an estimated 99 percent survival (Heinle and Olsen 1980).

Rock Island Dam

Spill is the preferred juvenile bypass measure at Rock Island Dam, but its use is limited due to total dissolved gas production.

As outlined in the Rock Island Settlement Agreement, spill at Rock Island Dam was conducted through a Fisheries Conservation Fund, which allowed the fishery regulatory agencies to request spill at their discretion up to a limit of \$2,050,000 (1986 dollars and increased for inflation) in lost energy revenue per year. Beginning in 2000, however, spill volumes between 21 and 41 kcfs were voluntarily provided, with the exact levels determined from the results of fish survival studies conducted in 2000 and 2001. In addition, similar to the operations at Rocky Reach Dam, the Chelan County PUD has agreed to implement HCP spill provisions in 2002 with the expectation that the HCP will be approved. As a result, the current spill program provides an equivalent of 20 percent of the daily estimated flow during the period encompassing 95 percent of the spring and summer juvenile migration periods (typically April 15 to June 15 and July 1 to August 15, respectively). If the HCP is not approved, the spill program could revert to the spill program implemented prior to 2000.

The PUD has modified several existing spill gates to allow for more surface-oriented spill and increased fish passage efficiency. During the 1998 spring migration, the Chelan County PUD spilled approximately 25 percent of the total daily

river flow and passed about 27 percent of the yearling chinook and 26 percent of juvenile steelhead (Iverson and Birmingham 1998). These estimates are similar to estimates provided by radio-tag evaluations in 1999 and 2000, when about 30 percent of radio-tagged steelhead and 25 percent of radio-tagged chinook salmon passed the project through the spillway (Lady et al. 2000; Skalski et al. 2000).

The total direct survival through the modified bays was estimated at 96.4 percent, compared to a 98.4 percent survival through a standard bay (Normandeau Associates and Skalski 1998). However, the study also concluded that the reduced survival rate for the modified bay was the result of the shallow stilling basin at that location.

A subsequent study indicated that survival rates through modified bays with deeper stilling basins may be near 100 percent, although this has not been verified for all river flow and spillway operational conditions (Normandeau Associates 1999). Lady et al. (2000) also estimated spillway survival at about 100 percent for radio-tagged steelhead. However, a conservative estimate of 98 percent average is the assumed direct survival rate for fish passing through spill at Rock Island Dam for all species, which is consistent with the estimates for other spillways in the Columbia River Basin.

2.2.3.2 Adult Passage

Adult salmon and steelhead pass upstream through the Mid-Columbia River PUD dams via fishways that were typically installed during the original construction of the projects. The fishways consist of an entrance gallery and ladder, a diffuser system that provides additional water at the ladder entrances to attract upstreammigrating adult fish, and a flow control section that maintains ladder flow over varying forebay elevations. Migrating adults can be delayed as they search for fishway entrances, although delays are also likely to occur at the entrances and in the collection galleries. The operation of adult

fishladder traps (such as at Bonneville, Priest Rapids, and Wells dams) can result in additional delays. The delay and stress that adults experience during passage through multiple dams may reduce their spawning success. For example, those adults destined for the Methow River must pass through four Federal dams and five PUD dams before reaching their spawning grounds.

Observed total passage times for adult chinook and sockeye salmon have ranged between 5 and 47 hours at Wells Dam, between 23 and 37 hours at Rocky Reach Dam, and between 15 and 39 hours at Rock Island Dam (see Table 2-4). Passage time for adult steelhead ranged between 4 and 26 hours at the three projects.

Under certain conditions, adult salmon and steelhead may also travel back downstream over a dam. Downstream passage can occur over spillways or through fishladders, turbine units, or juvenile bypass systems. Downstream passage or "fallback" can be either involuntary or voluntary. Voluntary fallback typically occurs when adults have unintentionally passed a specific tributary or hatchery and are moving back downstream in search of these natal areas. In addition, postspawning steelhead (kelts) pass downstream to return to the ocean. Involuntary fallback occurs when adults are inadvertently entrained in flows through these passage routes, and must reascend the ladder before continuing their migrations to reach their natural spawning grounds or hatchery.

Studies in the Lower Columbia and Snake Rivers have found that direct adult mortality in the fishways is likely small under normal passage conditions. However, adults that fall back over the dam can suffer injury or mortality. Studies of mortality rates for fish that fallback through hydroelectric projects have ranged substantially, from lows of 3 and 5 percent at Bonneville Dam to nearly 25 percent at the Lower Granite Dam. In general, mortality rates tend to be higher for fish falling back through the turbines than through spillways or juvenile bypass facilities (NMFS 2000a).

Studies of the Mid-Columbia River projects have estimated fallback rates similar to those observed at other Columbia River Basin projects, although these studies have not estimated mortality rates due to fallback (see Table 2-4). Fallback rates at the Mid-Columbia River dams (Wells, Rocky Reach, and Rock Island dams) have ranged between 0 and 21 percent for chinook salmon (Stuehrenberg et al. 1994; English et al. 1998a and 2001; and Alexander et al. 1998).

In two separate studies, steelhead fallback estimates (which are different from the downstream migration rates of post-spawning steelhead [kelts]) at Wells Dam ranged between 6 and 7 percent. Alexander et al. (1998) reported that one of 16 radio-tagged steelhead (6.3 percent) detected upstream of Wells fell back through the project. These fish did not reascend the project fishways, and many of them were eventually located in the Wells Fish Hatchery outfall, suggesting a substantial voluntary fallback rate. Similarly, English et al. (2001) reported that 11 of 162 fish (6.8 percent) fell back in 1999. Of these fish, five fish (45 percent) reascended the project ladders.

Estimated steelhead fallback rates at Rock Island and Rocky Reach dams were 3 and 5 percent, respectively, in 1998 (English et al. 1998a), and 7 and 10 percent, respectively, in 1999 (English et al. 2001). Eight of the 22 steelhead (36 percent) that fell back at Rock Island Dam in 1999 reascended the fishladders, while only two of 21 steelhead fallbacks (10 percent) at Rocky Reach Dam reascended the project. Sockeye fallback rates in 1997 were 3.5 percent at Wells Dam (English et al. 1998b), 14 percent at Rocky Reach, and 3.5 percent at Rock Island (English et al. 1998a).

Survival rates of adult salmon and steelhead passing through the Mid-Columbia River have not been estimated due to the inability to differentiate tag loss, tag failure, and fish loss. It is not presently possible to measure adult survival with existing technology. Although radio-

telemetry studies provide information on adult passage and apparent spawning distribution, uncertainties associated with the technology, and the inability to determine the ultimate fate or spawning success of radio-tagged fish, result in insufficient data to accurately estimate survival. In addition to the uncertainties related to the survival estimates developed through radio-telemetry data, it is not possible to differentiate natural mortality from project-related mortality.

English et al. (2001) reported that 81 percent of radio-tagged adult steelhead were tracked to known Mid-Columbia River spawning areas, while the other 19 percent were last tracked in the Columbia River mainstem and various hatchery outfall sites (Wells, Eastbank, and Ringold Springs). Despite the uncertainties associated with radio-telemetry data, such studies can provide estimates of minimum adult survival. The estimated survival rates of Upper Columbia River steelhead and spring-run chinook salmon migrating through the Lower Columbia River dams (from Bonneville to McNary dams) averaged 96.8 and 97.6 percent per project, respectively (NMFS 2000a). However, because of the uncertainties described above, these are minimum estimates of survival.

Recent evidence suggests a substantial number of adult steelhead kelts migrate downstream through the Mid-Columbia River. The overall estimate of radio-tagged adult steelhead outmigrating as kelts in the Mid-Columbia River ranged from 34 to 69 percent (English et al. 2001). The wide range in the estimate was primarily due to uncertainties in the data because juvenile fish with some of the same radio-tag codes were released during the kelting period.

2.2.3.3 Fishladders and Other Passage Protection Facilities

Each of the three dams has at least one fishladder for adult salmon and steelhead to pass upstream. Wells has two fishladders, Rocky Reach has one, and Rock Island has three. These ladders are typically along the banks of the river, although one of Rock Island's ladders is in the center of the dam. The ladders operate continuously, except for brief maintenance periods in winter. The ladders operate under criteria approved by relevant fisheries agencies.

Rocky Reach and Rock Island dams have adult collection channels along the downstream length of the powerhouse. Each of the fishladders at Wells has a separate collection gallery located on either side of the hydrocombine powerhouse. The channels use attraction flows to redirect fish toward the fishladders. All the dams have stations for counting adult fish passage. Adult traps are located within both fishladders at Wells Dam. These traps are used for collection of broodstock and for stock assessment purposes.

Adult Reservoir Passage

Once adult fish migrate upstream past a dam successfully, they must swim through a reach of river that has changed substantially from its historic, free-flowing conditions. The reservoirs have reduced water velocity and increased holding area compared to natural river conditions. These changes could benefit migrating adults by decreasing travel times and adult energy consumption. Hydroelectric and water storage projects have altered the thermal regime of the Mid-Columbia River. Compared to pre-project conditions, the thermal inertia of these projects has resulted in lower maximum summer temperatures, higher minimum winter temperatures, cooler spring temperatures (delayed warming), and warmer fall temperatures (delayed cooling). For some species, these changes may lead to higher pre-spawning mortality. Relative to the large storage projects, run-of-the-river projects (such as the three PUD projects) have limited capacity to affect water temperature because of their relatively short retention times (only a few days) (BPA et al. 1994a). Thus, the Mid-Columbia River projects do not appear to significantly affect water temperatures.

Decreased water velocity in reservoirs does appear to facilitate more rapid upstream migration of adult salmon and steelhead. Prior to dam construction, chinook salmon migrated upstream in the Snake River at rates of 12 to 14 miles per day (Bjornn and Peery 1992). Adult spring/summer chinook migration rates through the free-flowing river sections of the Snake River, upstream of Lower Granite Dam, range from 6 to 19 miles per day, while steelhead migration rates are typically less than 7 miles per day (NMFS 2002a). Steelhead migrated upstream in the unimpounded Lower Columbia River at rates of 7 to 11 miles per day (Chapman et al. 1994a), and sockeye migrated at rates of 17 miles per day (Biornn and Peery 1992) (Table 2-5).

Spring/summer chinook migration rates through the Snake River reservoirs in 1991 to 1993 ranged from 31 to 65 km/day (Bjornn 1998). The median migration rate for steelhead through the Snake River reservoirs in 1993 was 30 km/day while migration rates through the free flowing sections of the river were generally less than 11 km/day (Bjornn 1998). Bjornn et al. (1999) estimated that the median migration times for spring/summer chinook and steelhead passing through the four Snake River dams and reservoirs was the same or less than without dams present.

Migration rates for these species in the Rock Island and Rocky Reach reservoirs in 1997 ranged from 14 to 58 miles per day (English et al. 1998b, 2001). These data suggest that adult salmon and steelhead that successfully pass through Columbia River reservoirs have decreased travel times when compared to unimpounded systems. When considering passage through the reservoirs and dams, adult anadromous salmonids appear to be capable of migrating at similar rates to fish migrating through unimpounded river sections. English et al. (2001) reported that the median travel speed for steelhead adults migrating from the Priest Rapids Dam tailrace to the upstream fishladder exit at Wells Dam was 13 miles per day, which is within the range of the estimated preimpoundment travel speeds.

Juvenile Reservoir Passage

Reservoir impoundments can create increased rearing area and provide overwintering habitat for juvenile anadromous salmonids. The slower water velocities can also affect the outmigration of anadromous salmonid juveniles by causing extended travel times and decreased survival rates. The use of the term "extended travel times" refers to slower rates of travel by outmigrating juvenile anadromous salmonids. The extended travel time, low water velocities, and increased water temperatures in the reservoirs, compared to the unimpounded river, results in greater energy expenditures by juvenile migrating fish.

Extended travel times due to passage through reservoirs also increase potential exposure of juvenile outmigrants to predatory fish and reduces migration survival (BPA at al. 1994c). Delays in fish reaching the estuary are also suspected of affecting the survival of juveniles during their smoltification and acclimation to salt water. However, limited estuary survival data is available to determine the extent that arrival time influences survival.

Survival estimates for yearling chinook and steelhead through the Rocky Reach Project ranged between 96 and 97 percent (Eppard et al. 1999; Bickford et al. 2001). However, these estimates were derived from single release-recapture methods that do not include all the potential sources of mortality at the dam but does include all of the mortality experienced from passing through the Rocky Reach reservoir and part of the mortality from passing through Rocky Reach Dam.

2.2.3.4 Fish Production

Hatchery Facilities

The Chelan and Douglas County PUDs own six main hatchery facilities that produce fish as mitigation for project impacts (Table 2-6). Through agreements, five of these facilities are operated by WDFW, and the sixth facility (the experimental Cassimer Bar sockeye hatchery), was operated by the Colville Tribe. However, this facility was relatively unsuccessful and was phased out in favor of a flow management program in the upper Okanogan River Basin to improve the production of naturally spawning sockeye salmon. Each year, the PUDs interact frequently with the operators on issues such as mitigation, compliance, funding, facility maintenance, and special projects.

The Douglas County PUD operation of the Wells Hatchery has previously received a Section 10 permit (#1094, issued to WDFW on February 4, 1998). NMFS has also completed a biological opinion on that permit, although this permit expires in May 2003. A subsequent permit (#1395) will be issued in late 2002. The Methow Fish Hatchery spring-run chinook program was considered in the review of Section 10 permit #1196 to WDFW, and NMFS has completed a biological opinion for that permit (NMFS 2002c).

The Chelan County PUD operations of the Turtle Rock and Chelan Falls hatchery facilities have also previously received a Section 10 permit (#1094 to WDFW, as discussed above). A spring-run chinook salmon program at the Eastbank and Chiwawa facilities was considered in a review of Section 10 permit #1196 to WDFW, and NMFS has completed a biological opinion for that permit (NMFS 2002c).

Reservoir and Tributary Production

The majority of the mainstem spawning habitat for anadromous salmonids in the Mid-Columbia

River reach was inundated by the formation of the five PUD reservoirs between Priest Rapids Dam (river mile 397.1) and Chief Joseph Dam (river mile 545.1). The total surface area of the Columbia River between Priest Rapids and Chief Joseph dams doubled from 23,000 acres to 46,000 acres following inundation by the dams (Mullan et al. 1986). Since upstream passage facilities were not provided when the Chief Joseph Dam was constructed, this dam is currently the upstream extent of mainstem anadromous salmonid production.

Current natural anadromous salmonid spawning in the mainstem Mid-Columbia River is limited primarily to the free-flowing Hanford Reach downstream of Priest Rapids Dam, the tailrace of Wells Dam, and to the major tributaries including the Wenatchee, Chelan, Entiat, Methow, and Okanogan River systems. Mainstem spawning also occurs in tailrace areas where streambed hydraulics and substrate conditions are favorable (Carlson and Dell 1989, 1990, 1991, 1992; Dauble et al. 1994; Chapman et al. 1994b). Reservoir production concerns and issues are related to a reduction in fish habitat for spawning and juvenile rearing life-history stages, as well as aquatic productivity and predation (Mullan 1986; Rondorf and Gray 1987). A more detailed description of existing spawning and rearing habitat is provided in Section 3.2, Fisheries Resources.

2.2.3.5 Fish Transportation on the Mid-Columbia River

None of the Mid-Columbia River mainstem projects have navigation locks. Consequently, the transportation of fish potentially collected at the three projects would have to rely on trucking. New systems would need to be developed to collect and transfer fish around each dam or into transportation facilities.

ADULT SALMONID MIGRATION RATES THROUGH IMPOUNDED AND UNIMPOUNDED WATERS OF THE LOWER COLUMBIA, MID-COLUMBIA, AND SNAKE RIVERS (MILES/DAY) **TABLE 2-5.**

	UNIMP	JNIMPOUNDED		IMPOUNDED	
	SNAKE RIVER	COLUMBIA RIVER	SNAKE RIVER	COLUMBIA RIVER	MID-COLUMBIA RIVER
Chinook	6-19		19-40	15	36
Steelhead	7	7-11	19		13-22
Sockeye	11	17		15	25

Source: Bjornn et al. 1995; Bjornn and Peery 1992; Chapman et al. 1994a,b; Stuehrenberg et al. 1995; Swan et al. 1994; English et al. 1998b; NMFS 2002a; English et al. 2001.

FISH PRODUCTION FACILITIES OWNED BY THREE MID-COLUMBIA RIVER PUDS **TABLE 2-6.**

						PROD	PRODUCTION FACILITIES	NES		TOTAL	WATER SUPPLY (CFS)	PLY (CFS)
FACILITY / SATELLITE	OWNER	OPERATOR	OWNER OPERATOR COMPENSATION OBJECTIVE	YEAR CON- STRUCTED	ADULT HOLDING	INCUBATION RACEWAYS	RACEWAYS	Ponds	NET PENS	VOLUME (CF)	SURFACE WATER	GROUND
Chelan Hatchery	CCPUD/ WDFW	WDFW	Original Rocky Reach pool inundation and current project mortality	1965	yes	yes	yes	<u></u>	on	71,500	0	ထ
Eastbank Hatchery	CCPUD	WDFW	Original Rock Island pool	1989	yes	yes	yes	yes	2		0	53
Carlton Pond			inundation and current	1989	2	5	0	yes	01	53,400	15	0
Chiwawa Pond			project mortality	1989	2	۶	0	yes	92	150,000	21	0
Dryden Pond				1989	2	2	5	2	92		8	0
Lake Wenatchee Net Pens	S			1989	yes	9	2	2	yes	59,200	N/A	0
Similkameen Pond				1989	2	2	2	yes	9	92,400	21	0
Methow Hatchery	DCPUD	WDFW	WDFW Assumed Wells project	1992	yes	yes	yes	yes	91	62,500	8	9
Chewuch Pond			mortality for spring-run	1992	yes	2	2	yes	2	25,000	9	0
Twisp Pond			cninook, sockeye, and summer chinook	1992	yes	2	2	yes	2	25,000	9	0
Wethow Pond				1992	yes	92	2	yes	2	25,000	9	0
Rocky Reach Hatchery	CCPUD	WDFW	Original Rocky Reach pool	1969	2	yes	yes	2	0	29,000	0	9
Turde Rock Pond			inundation and current project mortality	1974-1984	2	2	ou	yes	9	176,200	4	0
Wells Hatchery	DCPUD	WDFW	Original Wells pool inundation and assumed project models.	1967	yes	yes	yes	yes	9	991,636	171.8	19.8
CV.			project montainty									

CCPUD = Chelan County PUD DCPUD = Douglas County PUD

2.2.4 OTHER KNOWN HYDROPOWER EFFECTS

2.2.4.1 Water Quality

Total dissolved gas supersaturation is a condition that occurs in water when atmospheric gases are forced into solution at pressures that exceed the pressure of the over-lying atmosphere. Water containing more than 100 percent total dissolved gas is in a supersaturated condition. Water may become supersaturated through natural or damrelated processes that increase the amount of air dissolved in water. Supersaturated water in the Columbia River results from spilling water at the Mid-Columbia River projects and at upstream and downstream projects. Fish and other aquatic organisms that are exposed to excessive total dissolved gas supersaturation can develop gas bubble disease, which, in extreme cases, can be fatal to anadromous salmonids and other aquatic organisms.

The occurrence of total dissolved gas supersaturation in the Columbia River system is well documented and has been linked to mortalities and migration delays of salmon and steelhead (Beiningen and Ebel 1970; U.S. Army Corps of Engineers 1993; Gray and Haynes 1977). Total dissolved gas supersaturation in the Columbia and Snake Rivers was identified in the 1960s and 1970s as a detriment to salmon and steelhead, and those concerns have reappeared as management agencies have reinstituted spill as a means of aiding fish passage around hydropower facilities (NMFS 1995).

Total dissolved gas supersaturation occurs in the Columbia River during periods of high run-off and spill at hydropower facilities, primarily because spill in deep tailraces can cause significant entrainment of gases. Water passed through turbines does not increase gas saturation to any appreciable degree (BPA et al. 1994a). The majority of the variation in total dissolved gas measured just downstream of spillways is explained by the amount of spill. The second

most influential variable is spillway plunge depth as indicated by tailrace elevation and stilling basin depth (BPA et al. 1994a). Total dissolved gas supersaturation varies substantially by season and by dam.

In addition to depth and pressure, gas supersaturation can be affected by water temperature. As water temperature increases, the amount of dissolved gas that can be held in solution decreases, resulting in greater relative percentages of dissolved gas levels. The consideration of temperature effects is important in the Columbia River, where water temperatures vary daily and seasonally during salmon and steelhead migrations, and where temperature regimes have been altered by hydropower projects (Beiningen and Ebel 1970).

Within the Mid-Columbia River, Douglas County PUD has modified the spillways at Wells Dam into an effective and efficient juvenile fish bypass system. This system minimizes the amount of spill needed to efficiently pass juvenile fish at the project, thereby minimizing the effect on total dissolved gas. The spillway at Rocky Reach Dam has been shown to cause only slight increases in total dissolved gas under most conditions and may reduce gas levels under certain conditions (Parametrix 2000a). In addition, the construction of the juvenile fish bypass facility at Rocky Reach will minimize the amount of spill needed to effectively pass fish at the project. Spillway modifications at Rock Island Dam are aimed at increasing the efficiency of the spillway at passing juvenile fish to minimize the spill requirements there. More information on total dissolved gas and other water quality effects on fish is provided in Section 3.3.2, Water Quality.

2.2.4.2 Water Temperature

The thermal regime of the Mid-Columbia River is influenced by releases at Grand Coulee Dam and other upstream storage dams. Run-of-the-river projects, such as the three PUD projects, may have limited capacity to affect water temperature

because they have short retention times (only a few days) (BPA et al. 1994a). For example, temperature evaluations conducted in Rocky Reach reservoir in 2001 suggest that the project appears to influence some warming in July and August and some cooling in September and October. These differences were estimated to be on the order of 0.9° and 0.7° F (0.5° C and 0.4° C), respectively (Parametrix and Thomas R. Payne & Associates 2002). Thus, the Mid-Columbia River projects do affect water temperatures at times. The effect of these changes on anadromous salmonids is equivocal, but likely small.

High water temperature is a key water quality issue for the region, particularly during low-flow conditions. High water temperature can pose a significant problem for salmon and steelhead. Warmer water can increase the incidence of disease; increase the energy demands of migrating fish; alter the timing of adult and juvenile migrations; change incubation, hatching and maturation times; and affect gas supersaturation (BPA et al. 1994a; Chapman et al. 1994b, 1995a; Dauble and Mueller 1993). In addition, given sufficient magnitude and duration of exposure, high water temperatures can be lethal to fish.

Water temperatures exceeding 66° to 70° F (19° to 21° C) have been shown to cause delays in migrating adult anadromous salmonids (Dauble and Mueller 1993). Within the Mid-Columbia River region, no delay of migration has been observed on the mainstem, but warm water flowing out of the Okanogan, Methow and Wenatchee Rivers has caused fish to remain in the mainstem until temperatures decreased (Alexander et al. 1998). Spawning fish have limited energy reserves, and any delay in migration may reduce those energy reserves to the point where the fish may not be able to spawn successfully (BPA et al. 1994a). High temperatures not only reduce energy reserves by extending the period of migration but also by increasing the metabolic rate of the fish.

Lethal water temperatures for juvenile spring-run chinook and sockeye salmon are 77° and 76° F (25.1° C and 24.4° C), respectively (Brett 1952). Adult anadromous salmonids are generally less tolerant of high water temperatures. When exposed to temperatures of 70° F (21° C) or more for greater than 7 days, 50 percent of adult salmon and steelhead populations experience mortality (Dauble and Mueller 1993). Nevertheless, mortality of fish may not be observed even when recorded temperatures exceed known lethal thresholds because fish may avoid high temperatures by ceasing migration or seeking out areas of cooler water (e.g., areas of in-channel groundwater upwelling).

Water temperatures at levels that may not directly kill anadromous salmonids may cause indirect stress-related mortality (Dauble and Mueller 1993). In addition, the rate of pre-spawning mortality can be increased by warm temperatures in combination with other stresses, such as disease through pathogenic agents and total dissolved gas (Dauble and Mueller 1993). Refer to Section 3.3.2.1, Project Area, for more information on stream temperatures.

2.2.4.3 Predation

Construction of hydropower facilities on the Mid-Columbia River has created impoundments with habitat more conducive to predators compared to the pre-impounded free-flowing river. Changes in physical habitat, water quality, and downstream passage conditions have combined to increase the abundance of predators and the risk of juvenile outmigrant mortality due to predation (Mullan et al. 1986; Chapman et al. 1994b).

Dams present an obstacle to the downstream migration of juvenile anadromous salmonids, often causing them to concentrate in forebays before finding a route past the dam.

Concentrations of juvenile anadromous salmonids provide a ready food supply for predators that congregate at such sites (Beamesderfer and Rieman 1991). Passage through turbines,

spillways, or bypass facilities may stun, disorient, or injure some juvenile anadromous salmonids, making them less capable of escaping predators.

Sediment that formerly would have been suspended during high spring flows settles out in upstream impoundments, resulting in reduced turbidity in the Mid-Columbia River. Clearer water makes juvenile outmigrants potentially more visible and more susceptible to predation (Reid et al. 1988).

The deep, low-velocity habitat created by impoundments is preferred by northern pikeminnow, the major native predator fish of juvenile anadromous salmonids. Two game fish species, walleye (*Stizostedion vitreum*) and smallmouth bass (*Micropterus dolomieuri*), were introduced into the Columbia River system in the 1940s to 1950s to provide sport fishing opportunities (Henderson and Foster 1956; Zook 1983). These piscivorous game fish have become established in the Mid-Columbia River reservoirs, and prey on juvenile anadromous salmonids.

In addition to piscivorous fish species, juvenile salmonids are also susceptible to predation by avian predators. High concentrations of avian predators have been observed in the project vicinities during juvenile outmigration periods. Ruggerone (1986) estimated that avian predators consumed an estimated 2 percent of all juvenile salmonids passing Wanapum Dam and may be higher for certain species. Similar estimates are likely for the other Mid-Columbia River projects.

Dams and reservoirs in the Columbia River Basin generally increase the availability of microhabitats preferred by these predator species. As a result of project operations or geometry, juvenile salmonids may also be concentrated into specific areas of the forebay or tailrace, where predator species are also typically found in higher concentrations. Thus, dams are thought to generally increase the susceptibility of juvenile salmonids to predators and the incidence of

predation compared to historic levels (NMFS 2000d).

Chelan and Douglas County PUDs have developed predator control programs at each of their projects to minimize the predation risks to juvenile salmon and steelhead. Each project has instituted programs to catch and remove predator northern pikeminnow from areas adjacent to the projects. These are typically hook-and-line fishing programs in the forebay and tailrace areas of the projects. Through 2002, over 52,000 northern pikeminnow were removed from the Wells Project area (Bickford 2002 personal communication). Between 1994 and 2002, nearly 51,000 northern pikeminnow were removed from the Rocky Reach Project area, and between 1995 and 2002, nearly 36,500 northern pikeminnow were removed from the Rock Island Project area (West 2002 personal communication). Through several unique programs (e.g., fishing derbies, long-line fisheries) implemented since 1996, approximately an additional 30,000 northern pikeminnow were removed from the Rock Island and Rocky Reach Project areas (West 2002 personal communication).

Bird predation is also minimized by several activities funded by the PUDs. Avian predator deterrent wires have been installed across portions of the tailraces to reduce piscivorous bird access to these areas, where juvenile fish are highly susceptible to predation. In addition, propane cannons and other pyrotechnic methods have been used to haze gulls and other piscivorous birds further downstream of the projects. As is deemed necessary, lethal shooting of individual birds is also employed. The intent of such shooting is to enhance the efficiency of the propane cannons and pyrotechnics by training birds to anticipate injury when they hear explosions. Birds that learn to fly beneath the avian predator deterrent wires, at certain projects, are shot. These protective measures are similar to programs used throughout the Lower Columbia and Snake Rivers, and effective at reducing predation in the immediate project areas.

2.3 ALTERNATIVES CONSIDERED IN DETAIL

2.3.1 Introduction

The alternatives developed for this EIS include the practicable project conservation measures that could be implemented to improve fish passage conditions at the three Mid-Columbia River hydroelectric projects. These measures are based on the purpose and need of the proposed action, which is to help protect and recover anadromous salmonids while allowing the PUDs to continue to generate power to meet the Pacific Northwest power demands. However, the PUDs ability to generate power varies considerably between the alternatives considered in this EIS (see figures F-10, F-11, and F-12, in Appendix F).

2.3.1.1 Species Considered

The intent of the conservation measures described within the three alternatives presented in this EIS are for the protection and recovery of anadromous fish species (including endangered spring-run chinook, summer/fall chinook, sockeye, and coho salmon, and endangered steelhead) at the three hydroelectric projects.

2.3.1.2 **Timeline**

For comparative purposes, the timeline considered under this EIS for all three alternatives is 50 years—the term of the HCP applications for Wells, Rocky Reach, and Rock Island projects. Alternative 1 (no-action alternative) represents existing conditions and assumes that the ongoing conservation measures at each project will continue relatively unchanged over the next 50 years. Alternative 2 includes conservation measures that could be implemented over the next 50 years given the best scientific information available today concerning the expected relative benefit of each measure and resulting likelihood of implementation.

Specific goals, tools, and costs associated with Alternative 2 are the most difficult to project because no specific programs have been established. Those conservation measures that have proven to be ineffective in protecting and recovering anadromous fish at the three project sites considered in this EIS are not included in Alternative 2, but are described as alternatives considered but eliminated from detailed evaluation (Section 2.5, Alternatives Considered But Eliminated from Detailed Study). Alternative 3 provides goals, tools, and costs to implement the passage survival requirements over the 50-year term of the HCPs.

2.3.1.3 Location of Conservation Measures

Conservation measures for Alternatives 1 and 2 would occur at the project sites. Existing licenses typically require either facility improvements to increase the survival of fish passing through a project or mitigation in the form of hatchery production. Under Alternative 3, the PUDs have voluntarily offered to aid in the recovery of anadromous fish species by contributing to offsite habitat improvements in the Mid-Columbia River area, including the four tributaries: Wenatchee, Entiat, Okanogan, and Methow Rivers. Alternatives 1 and 2 are based on federal regulatory laws, which do not mandate off-site conservation measures and therefore do not include tributary habitat improvements.

2.3.1.4 Direction, Guidance, and Coordination

Direction for anadromous fish species protection is through FERC licenses, license amendments, and compliance with the Endangered Species Act. Under Alternative 1, evaluation programs for fishery conservation measures and procedures are conducted through coordinating committees for the Wells, Rocky Reach, and Rock Island projects. These committees provide for coordination among the PUDs, their power purchasers, and the Joint Fisheries Parties. Decisions made by the coordinating committees are by consensus. While it is unclear whether measures adopted under Alternative 2 would include the use of the existing coordinating committees, the EIS evaluation assumes that a coordinating committee similar to that described for Alternative 1 would be established. The coordinating committees under Alternatives 3 have unique members, procedures, and monitoring and evaluation requirements (see Section 6 of the Wells HCP and Section 4 of the Rocky Reach and Rock Island HCPs). In addition, Alternative 3 would have tributary and hatchery committees for each project. More detailed committee information for Alternative 3 is provided in Section 2.3.4, Alternative 3 (Proposed Action-Project HCPS).

2.3.2 ALTERNATIVE 1 (No-ACTION)

Alternative 1 represents baseline conditions, which include the FERC licenses and amendments that govern current operations. These licenses cover all aspects of dam operation, as well as environmental resource protection. Under Alternative 1, analyses in this EIS review how the licenses and the applicable amendments affect the environmental resources within the project area.

Provided below are the protection measures associated with Alternative 1 that are pertinent to anadromous fish for direct comparison to Alternatives 2 and 3. The effects of these fish prescriptive measures on other environmental resources, (including resident fish), are described in Chapter 4 of this EIS.

2.3.2.1 Wells Hydroelectric Project

The original FERC license stipulated that two adult fishladders would be constructed at the

Wells Project (adjacent to each embankment), as well as a low bucket spillway design that was approved by the State of Washington Department of Fisheries and Game (FERC 1962a). A subsequent amendment to the license stipulated a general requirement to provide mitigation for project construction, alteration, and operations, and to comply with reasonable requests to modify project structures and operations in the interest of fish and wildlife (FERC 1962b). Project structure revisions were approved in 1970 to comply with fishery agency requirements regarding fishladder design and operation (FERC 1970). FERC (1982) amended the license to raise the forebay elevation by 2 feet.

In 1990, the Douglas County PUD, the Wells Project power purchasers, resource agencies, and Tribes entered into a long-term fisheries settlement agreement regarding the Wells Project (FERC 1991). The 1990 Wells Settlement Agreement established the requirements for the Douglas County PUD to fund, operate, maintain, and evaluate three anadromous fish-related programs through at least March 1, 2004. These programs consist of: (1) juvenile downstream migrant fish passage measures, (2) adult passage measures, and (3) hatchery-based compensation measures for fish loss. These measures, in conjunction with existing hatchery compensation programs, were considered to fulfill Douglas County PUD's obligation to protect anadromous fish and mitigate and compensate for the effects of the Wells Project on anadromous fish. The agreement also stipulates evaluation programs for fishery measures and establishes procedures for coordination among the PUD, its power purchasers, and the Joint Fisheries Parties through the Wells Coordinating Committee.

Section 7 consultation, pursuant to the provisions of the Endangered Species Act, has been completed for the interim protection plan involving the operation of the Wells Project (NMFS 2000b), although this coverage expired as of April 1, 2002. However, Douglas County PUD continues to operate the project in

accordance with the 2000 biological opinion in anticipation that its HCP will be approved. Because these provisions have not formally been incorporated into the existing FERC license, they are not considered part of Alternative 1.

Juvenile Fish Passage

The juvenile fish passage program called for the installation and evaluation of a juvenile bypass system to route juvenile anadromous salmonids away from the turbine units. The established program uses controlled spill through modified spill bays to provide an effective non-turbine passage route through the project. The agreement includes specific operation, performance, and evaluation standards, as well as procedural guidelines for modifying the operational components of the system if necessary to meet the performance standards. The performance standards are set to provide fish passage efficiency (the percentage of fish bypassing the project through non-turbine routes divided by the total population of fish passing the project). The established fish passage efficiency standards are at least 80 percent during the juvenile spring migration period and at least 70 percent during the juvenile summer migration period.

Adult Fish Passage

The 1990 Wells Settlement Agreement called for evaluations of adult passage delay and mortality at the project beginning in 1991. If the evaluations identified delays or mortality, the agreement specified that operational modifications would be used to alleviate the problems. If those modifications could not correct the problems, the adult fishways would be modified.

Hatchery-Based Compensation

Under the 1990 Wells Settlement Agreement, the PUD agreed to fund a hatchery program to mitigate for fish passage losses at the Wells Dam.

The agreement identifies specific production levels for the anadromous fish species affected by the project that are in addition to the existing mitigation program at Wells Dam. The agreement also provides the ability to adjust these additional compensation levels based on actual juvenile losses at the dam. However, production levels based on impacts of project inundation would not be altered. The agreement also establishes specific operational standards for the fish production facilities.

Measures Planned

The existing fish mitigation and compensation measures for the Wells Dam were developed through the 1990 Wells Settlement Agreement and subsequent agreements within the Wells Coordinating Committee. A summary of measures expected to either continue or be implemented under Alternative 1 are:

1. Adult Passage

- a. Continue operation and maintenance of the existing adult fishways.
- b. Investigate entrance and ladder modifications that may be necessary to improve ladder operations and minimize fish passage delay.
- c. Conduct appropriate evaluations to determine the best actions for correcting any significant delay.
- d. Develop solutions and implement corrective actions where adult passage problems are identified. Specifically, improve the efficiency of the existing fishways by maximizing the number of adult migrants that enter the facilities.

2. Juvenile Passage

a. Surface Bypass Operation – Operate at least one spillway bypass, throughout 80

- percent of the peak spring and summer juvenile downstream migrations, respectively.
- b. Avian Predator Control As defined in the Cooperative Service Agreement between Douglas County PUD and the USDA Animal and Plant Health Inspection Service, this program is expected to continue at the Wells Dam and Wells Hatchery. Although it is a voluntary program, it is relatively inexpensive to conduct and effective at increasing juvenile fish survival through the project.
- c. Gas Abatement Control downstream total dissolved gas levels under total river flows up to the 7-day 10-year peak flow event to 120 percent of saturation. The 120 percent saturation criterion is a special exemption that only applies when the dam is spilling water to aid the downstream migration of fish. At all other times, the criterion is 110 percent of saturation.

3. Hatchery Program

a. Continue to provide funding and hatchery capabilities to rear and release up to 49,200 pounds of spring-run chinook, 32,000 pounds of yearling summer chinook, 24,200 pounds of subyearling summer chinook, and 80,000 pounds of yearling steelhead, according to provisions in the settlement agreement. Sockeye production has been phased out because it has not lead to a substantial increase in adult returns. Approximately 15,000 pounds of spring-run chinook salmon would be substituted for the sockeye salmon production until 2005. After 2005, sockeye mitigation will be facilitated through the implementation of a set of flow management options that would increase the natural production of

- sockeye salmon in the Upper Okanogan River Basin.
- b. Under the settlement agreement, hatchery production for unavoidable losses could be reduced if survival studies indicate that fish passage mortality is less than the assumed 14 percent, which was the basis for the current mitigation level. Project survival studies indicate that for yearling spring-run chinook and steelhead, actual project survival averages 96.2 percent. As a result, hatchery compensation would be reduced under Alternative 1 from the existing 14 percent to about 3.8 percent.

4. Monitoring and Evaluation

- a. Juvenile Run Timing Utilize hydroacoustic and fyke net monitoring data to determine the timing of bypass system operations.
- Survival Develop and utilize the best techniques to estimate the survival of juvenile salmon and steelhead passing the project. Techniques may include the use of mark recapture methodologies.
- c. Total Dissolved Gas Monitoring –
 Monitor total dissolved gas levels and
 temperature at fixed location monitors in
 the forebay and downstream of the dam.
 Although this is a voluntary program, it is
 a program that is expected to continue
 given recent court rulings related to
 compliance with the Clean Water Act.
- d. Fish Counting Provide adult fish counts on a 24-hour basis.

2.3.2.2 Rocky Reach Hydroelectric Project

The existing fishery protection measures undertaken by the Chelan County PUD for the Rocky Reach Dam are the result of mitigation

and compensation requirements in the original project license and subsequent amendments (FERC 1953, 1957a,b, 1968), as well as interim stipulations executed in the Mid-Columbia Proceedings (Docket No. E-9569 [FERC 1987b]). The interim stipulations were temporary agreements between the Chelan County PUD and the Joint Fisheries Parties with respect to juvenile fish passage measures and hatchery compensation levels to mitigate for impacts resulting from project operations.

The first interim stipulation identified compensation and operational requirements that would be in effect from July 1, 1987 through August 31, 1988. Subsequently, the stipulation was extended and revised several times (FERC 1995, 1996a). The latest revision (Fourth Revised Interim Stipulation) was negotiated to include the period September 1, 1995 through December 31, 1997 (FERC 1996a). Although there is no current agreement for Rocky Reach, Chelan County PUD has continued to operate the project in coordination with the Mid-Columbia Coordinating Committee, as it has under the previous stipulations.

The Rocky Reach Dam has Section 7 Endangered Species Act coverage until 2006 through the biological opinion (NMFS 2002a) that was developed by NMFS in consultation with FERC for the construction and continued evaluation of the permanent juvenile fish bypass system.

Although the bypass option is a component of the Rocky Reach HCP, it was independently evaluated as part of a license amendment proceeding and was approved irrespective of future FERC actions on the HCP. Moreover, since construction of the permanent bypass system is not complete, the timing of its construction relates to the HCP, and represents a departure from the no-action condition. The bypass is therefore evaluated in this EIS as an HCP conservation measure under Alternative 3 (see Section 5.3.1 of the Rocky Reach HCP).

Juvenile Fish Passage

The main goal of the Fourth Revised Interim Stipulation was to develop a safe (less than 2 percent mortality) juvenile bypass system capable of bypassing 80 percent of the juvenile salmon and steelhead over 90 percent of the migration period. This agreement led to the development of a prototype surface bypass system that was installed at Rocky Reach Dam in the fall of 1994. Since that time, the bypass system has been modified based on the results of hydraulic modeling and fish passage evaluations. During development of the surface bypass system, the Fourth Revised Interim Stipulation provided a protection plan for juvenile migrants through the use of spill.

The prototype juvenile bypass system will be removed in the fall of 2002 and replaced with a permanent structure. Pile-driving activities required to construct the permanent bypass structure in the forebay have already begun. Completion of the permanent bypass system is expected to occur by the 2003 spring outmigration period. The regulatory approval to install the system was based on an environmental assessment and biological opinion. Since the bypass was approved, it is included under all the alternatives, but for reasons previously noted, it is evaluated under Alternative 3.

Chelan County PUD initiated a fish predator reduction program at Rocky Reach Dam in 1994, concentrating primarily on the removal of northern pikeminnow. Pikeminnow are the most significant predator fish in the Columbia River, and ongoing removal programs also occur throughout the lower river.

Between 1994 and 2002, nearly 51,000 northern pikeminnow have been removed from the Rocky Reach Project area (West 2002 personal communication). This program is implemented through the use of anglers, either hired directly or through the USDA Animal and Plant Health Inspection Service. Two additional fisheries

predator removal programs were also conducted in 1996 and 1999. The PUDs partially funded fishing derbies, which removed 13,935 northern pikeminnow. Chelan County PUD also funded a long-line test fishery in the fall of 1999 that removed an additional 6,496 northern pikeminnow. That program continued in 2002.

These predator removal programs appear to be altering the population structure of pikeminnow in the project area. The number of pikeminnow ascending the project ladders has declined over the years, and the catch rates have also declined. These results are consistent with the results of the predator removal programs in the Lower Columbia River (Friesen and Ward 1999).

Avian predator control measures, as defined in the Cooperative Service Agreement between Chelan County PUD and the USDA Animal and Plant Health Inspection Service, are expected to continue at the Rocky Reach Dam.

Adult Fish Passage

Under Alternative 1, Chelan County PUD would maintain and operate adult passage systems at the project according to the Detailed Fishway Operating Procedure criteria, or superior criteria developed through the use of specific study results of fish passage. The PUD would also operate the spill and turbine units in a manner that optimizes adult passage, while meeting requirements for juvenile passage. Adult and kelt steelhead fallback rates and kelt protection would be evaluated when implementing juvenile bypass options.

Hatchery-Based Compensation

Through the terms of the Fourth Revised Interim Stipulation, Chelan County PUD provides funding and hatchery capacity to compensate for anadromous fish production losses resulting from the initial inundation of the project. As with other portions of the stipulation, Chelan County PUD is expected to continue providing the same level of compensation under Alternative 1.

Measures Planned

Although the interim stipulation is expired, Chelan County PUD has continued implementation of the associated programs through the Mid-Columbia Coordinating Committee. In addition, NMFS has issued a biological opinion for the operation of the project and the construction of the juvenile bypass system (NMFS 2002a). This biological opinion provides specific measures for the protection of spring-run chinook salmon and steelhead, which were included in the license by amendment. The fish protection measures consistent with the Fourth Revised Interim Stipulation and the biological opinion (NMFS 2002a) include:

1. Passage

- a. Continue operation and maintenance of the adult fishways.
- b. Operate the powerhouse units within 1 percent of peak efficiency for a given head and power output, to the extent possible, and favor units 1 and 2 during the spring juvenile outmigration period.
- c. Construct a permanent juvenile bypass facility capable of bypassing 80 percent of the juvenile migrating salmon and steelhead over 90 percent of the migration period.

2. Gas Abatement

 a. Control downstream total dissolved gas levels under total river flows up to the 7day 10-year peak flow event to 120 percent of saturation. The 120 percent saturation criterion is a special exemption that only applies when the dam is spilling water to aid the downstream migration of fish. At all other times, the criterion is 110 percent of saturation.

3. Predator Control

- a. Continue to refine and implement a northern pikeminnow removal program.
- b. Continue avian predator control measures, as defined in the Cooperative Service Agreement between Chelan County PUD and the USDA Animal and Plant Health Inspection Service at the Rocky Reach Dam.

4. Hatchery Program

a. Continue to provide funding and hatchery facilities adequate to rear and release up to 54,400 pounds of fall chinook and 30,000 pounds of steelhead annually.

5. Spill Program

- a. Spill during the spring migration at a level equal to 15 percent of the daily average flow for 36 days, plus a potential additional 6 days spill at this level to provide additional protection for Okanogan River sockeye. During the summer, spill at a level equal to 10 percent of the daily average flow for a total of 34 days between June 15 and August 15 (see Table 2-3).
- b. As indicated in the Juvenile Fish Passage section, the spill program at the project is currently being implemented in accordance with the HCP provisions and the biological opinion (NMFS 2002a). If the HCP is not approved, the spill program is expected to follow the guidelines of the Fourth Revised Interim Stipulation for non-listed fish species until the project license expires in 2006. The spill program for the listed species would follow the guidelines in the 2002 biological opinion through 2006. Because

these spill measures are considered an integral component of the HCP, for the purpose of comparison, they are analyzed under Alternative 3 (see Section 5.4.1c of the Rocky Reach HCP).

6. Monitoring and Evaluation

- a. Survival Develop and utilize the best techniques to estimate the survival of juvenile salmon and steelhead passing the project. Techniques may include the use of radio- or acoustic-tags or tag release and recapture methodologies.
- b. Total Dissolved Gas Monitoring –
 Monitor total dissolved gas levels and
 temperature at fixed location monitors in
 the forebay and downstream of the dam.
 Provide biological monitoring to
 determine the incidence of gas bubble
 disease symptoms in adult anadromous
 salmonids.
- c. Fish Counting Provide adult fish counts on a 24-hour basis.
- d. Steelhead Kelt Losses Assess the feasibility to study steelhead kelt losses through the project.

2.3.2.3 Rock Island Hydroelectric Project

The original FERC license for the Rock Island Dam was issued in 1930, and construction was completed in 1933. In 1987, the Chelan County PUD, Puget Sound Energy (formerly Puget Sound Power & Light), resource agencies, and Tribes entered into a long-term fisheries Settlement Agreement for the Rock Island Hydroelectric Project (FERC 1987a). The provisions in the Rock Island Settlement Agreement were included in the new license for the project in 1989 (FERC 1989a). The Rock Island Settlement Agreement was amended in 1993 to replace the requirement to conduct an

adult fish mortality study with the requirement to conduct an adult fish passage study (FERC 1993a).

The 1987 Rock Island Settlement Agreement established the requirements for the PUD to fund, operate, maintain, and evaluate three anadromous fish-related programs. These programs consist of: (1) juvenile fish passage measures, (2) adult fish passage measures, and (3) hatchery-based compensation measures.

Juvenile Fish Passage

The Rock Island Settlement Agreement called for a bypass development program to study, design, develop, test, and install a mechanical juvenile fish bypass system at the project. The performance standards targeted for the bypass system included achieving at least 80 percent fish passage efficiency during the spring migration period and at least 70 percent fish passage efficiency during the summer migration period. Subsequent efforts to develop an adequate mechanical solution to the juvenile bypass issue were unsuccessful. The PUD is currently evaluating modifications at the spillway to increase the rate of non-turbine passage at the project and utilizing a conservation account to provide spill.

As an alternative to juvenile bypass system development, the agreement established and the Rock Island Coordinating Committee chose to implement a Fisheries Conservation Account. This account (with an annual funding level of \$2.05 million in 1986 dollars, which is currently assessed at \$3.2 million) could be used by the fishery agencies and the Tribes to purchase spill as a means to increase the non-turbine passage of juvenile fish at the project.

Chelan County PUD initiated a northern pikeminnow reduction program at Rock Island Dam in 1995, similar to the program described above for Rocky Reach Dam. Between 1995 and 2002, nearly 36,500 northern pikeminnow have

been removed from the Rock Island Project area (West 2002 personal communication). As at the Rocky Reach Project, the number of pikeminnow ascending the project ladders and the fishery catch rates have declined since the start of the program.

Avian predator control measures, as defined in the Cooperative Service Agreement between Chelan County PUD and the USDA Animal and Plant Health Inspection Service, are expected to continue at the Rock Island Dam.

Adult Fish Passage

The Rock Island Settlement Agreement called for modifications to the adult fishladders at Rock Island Dam to meet fishery agency operating standards, as well as a comprehensive hydraulic evaluation of the right bank ladder to ensure that the design flows were met. Under Alternative 1, Chelan County PUD would maintain and operate adult passage systems at the project according to the Detailed Fishway Operating Procedure criteria, or superior criteria developed through the use of specific study results of fish passage. The PUD would also operate the spill and turbine units in a manner that optimizes adult passage, while meeting requirements for juvenile passage. The PUD would evaluate adult and kelt steelhead fallback rates and kelt protection when implementing juvenile bypass or spillway modification options.

Hatchery-Based Compensation

Under the Rock Island Settlement Agreement, the PUD agreed to construct, maintain, and fund a hatchery program to mitigate for fish passage losses at the Rock Island Dam. The agreement identifies the specific construction standards, production levels, and evaluation procedures to be implemented. The agreement also provides the ability to adjust these additional compensation levels based on actual juvenile and adult losses at the project, although production levels intended to

compensate for project inundation would not be altered. The agreement establishes specific operational standards for the fish production facilities.

Measures Planned

The following fish protection measures were developed in the Rock Island Settlement Agreement and are included in Alternative 1:

- Modify the existing adult fishladders so their operation meets current fishery agency operating criteria.
- Utilize the conservation account to provide spill for spring and summer outmigrants, up to \$2.05 million (in 1986 dollars). However, as indicated in Section 2.2.3.1 (Juvenile Passage), the spill program at Rock Island Dam is currently being implemented in accordance with the HCP provisions (see Section 5.4.1a of the Rock Island HCP). If the HCP is not approved, the spill program is expected to return to following the conservation account provisions contained in the Rock Island Settlement Agreement.
- Continue to provide funding and hatchery capability to rear and release 250,000 pounds of salmon and 30,000 pounds of steelhead in a manner that is consistent with the maintenance of genetically distinct stocks.
- Evaluate fish guidance efficiency using hydroacoustic and direct capture methods, including assessments of injury and stress. Also review the hatchery programs (including sampling) to determine hatchery versus natural components of steelhead returns to evaluate hatchery production and its interrelationship with natural production.
- Gas Abatement Control downstream total dissolved gas levels under total river flows up to the 7-day 10-year peak flow event to 120 percent of saturation. The 120 percent

saturation criterion is a special exemption that only applies when the dam is spilling water to aid the downstream migration of fish. At all other times, the criterion is 110 percent of saturation.

- Continue to refine and implement a northern pikeminnow removal program.
- Continue avian predator control measures, as defined in the Cooperative Service Agreement between Chelan County PUD and the USDA Animal and Plant Health Inspection Service, at the Rock Island Dam.

The following measures would apply for monitoring and evaluation:

- Total Dissolved Gas Monitoring Monitor total dissolved gas levels and temperature at fixed location monitors in the forebay and downstream of the dam. Provide biological monitoring to determine the incidence of gas bubble disease symptoms in adult anadromous salmonids.
- Juvenile Fish Passage System Continue to evaluate non-turbine juvenile fish passage options, as agreed to through the Rock Island Coordinating Committee.
- Fish Counting Provide adult fish counts on a 24-hour basis.

2.3.3 ALTERNATIVE 2 (HYDROPOWER CONSERVATION MEASURES TO PROTECT ANADROMOUS FISH)

Alternative 2 assesses additional anadromous fish conservation measures that could be implemented through the Federal Power Act and the Endangered Species Act while allowing the continued operation of the three projects. Under the Federal Power Act, new or revised conservation measures for anadromous fish could be required during license reopener proceedings or relicensing. Each of the three projects is

scheduled for relicensing over the next 30 years with the Rocky Reach Project scheduled for relicensing in 2006, the Wells Project in 2012, and the Rock Island Project in 2028.

The opportunities to change conservation measures through license reopener clauses vary by project. Long-term settlement agreements have been reached for Rock Island and Wells dams that would limit some of the opportunities at these projects in the near term. However, there is no approved long-term agreement for Rocky Reach Dam, and relicensing procedures are currently underway to enhance the conservation measures for anadromous fish at that project.

Actions that would result in changes in conservation measures from existing conditions also include the potential for NMFS to request FERC to begin a proceeding under the reopener clause of the license and prepare a biological assessment on listed species due to a change in project operations, change in species status, identification of a species critical habitat that occurs in the project area, additional information related to project effects.

Due to a recent court decision, NMFS is currently reviewing the critical habitat designations for the Upper Columbia River Endangered Species Actlisted fish species. As a result, an additional consultation process might be required when a final critical habitat determination is made. If other species were listed under the Endangered Species Act in the future, additional consultation processes would also occur.

Under Alternative 2, compliance with the Endangered Species Act for the measures being considered by FERC is through the Section 7(a)(2) formal consultation process. With the assistance of each utility, FERC would provide NMFS with a biological assessment outlining the potential effects of the projects and any additional measures on listed species or their critical habitat

(once designated)¹. A typical biological assessment would include the following information:

- a description of the action being considered;
- a description of the specific area that may be affected by the action;
- a description of any listed species or critical habitat² that may be affected by the action;
- a description of the manner in which the action may affect any listed species or critical habitat¹:
- an analysis of the cumulative effects; relevant reports and analyses prepared on the proposal; and any other relevant studies or information on the action, the affected species, or critical habitat¹; and
- an evaluation of how the action might adversely affect Essential Fish Habitat as defined under the Magnuson-Stevens Fishery Conservation and Management Act for chinook and coho salmon.

NMFS would then evaluate this information and any other information available to determine whether the proposed action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat¹. NMFS would then write a biological opinion describing their conclusions regarding the potential impacts of the proposed action on the listed species. At that time, NMFS would also fulfill its obligations under the Magnuson-Stevens Fishery

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¹ A recent court ruling has vacated the critical habitat designations for the listed anadromous salmon. Although consideration of habitat requirements would be assessed during consultation to determine whether the proposed action is likely to jeopardize the species, additional consultation might be required after critical habitat designations are finalized.

Conservation and Management Act through an evaluation of the potential impacts of the proposed action on the Essential Fish Habitat of chinook and coho salmon.

Depending on their conclusions, NMFS could recommend additional protection measures to ensure that the proposed actions are not likely to jeopardize the continued existence of endangered species or result in the destruction or adverse modification of their critical habitat (once designated). Under this process, FERC would then have the responsibility of ensuring that measures identified in the biological opinion were implemented at the projects. The PUDs may either implement measures required by the biological opinion and FERC, or formally object to the mandatory requirements through litigation.

The protection of non-listed and anadromous species would be provided under the guidance of FERC. Although FERC and NMFS have not determined what, if any, additional measures would be required over the next 50 years to protect these species, it is likely that the agencies would require conservation measures that help to improve fish passage conditions at the projects and that do not result in adverse impacts to their habitat. However, the specific measures, the number of species covered, the proportion of the migrants covered, and the implementation schedule are substantial uncertainties associated with this alternative.

2.3.3.1 Conservation Measures

Relying on past and recently completed consultations at other mainstem Columbia and Snake River hydroelectric projects, Alternative 2 conservation measures would likely include a combination of the following:

 measures that allow for increased upstream passage of adult fish through fishways and reservoirs and decreased fish injury and prespawning mortality (examples include hydraulic and structural fishway

- improvements—specifically, ladder modifications and improved attraction flow to help move fish more quickly into the ladder systems and past the dams); and
- measures that provide for increased downstream passage of juvenile anadromous salmonids while minimizing fish injury (examples include increased spill programs [in association with operational and structural modifications to reduce total dissolved gas levels], expanded predator control programs (fish and avian), the development of improved fish bypass systems, and potentially, drawdown or dam removal).

These measures may be directed at both listed and unlisted salmonid species and would possibly only occur during specific periods (seasonal) to benefit a particular life stage. The specific measures for listed species may be independent and may not necessarily benefit all salmonid species.

Each measure implemented under Alternative 2 would continue until such time that FERC or NMFS determines that:

- other protective measures would better increase survival,
- the proposed measures are determined to be ineffective or unsuccessful in increasing fish survival, or
- a Federally listed species is delisted and it is determined that previously approved protection measure may safely be relaxed or are no longer warranted.

The decision to apply specific measures at each dam would depend on the benefit of the measures to anadromous salmonids. It is envisioned that each dam would have a combination of juvenile bypass options, including a screened bypass and/or a surface bypass system, a spill program designed to maximize non-turbine passage, fish

2-40

and avian predator control, and improvements to the adult facilities intended to maximize project and pre-spawning survival.

Initial survival standards for protection of listed species have been developed as a result of preliminary survival information and life-history analyses (draft Quantitative Analysis Report). The results of this life-history analysis is described in Chapter 5 and summarized in Appendix E.

2.3.3.2 Other Options Considered

If listed fish populations continue to decline, additional protection measures may be needed. Most of these additional measures would likely be in-water facility improvements.

Natural river drawdown is a remote possibility, and would have substantial environmental effects to many of the existing natural, physical, and social resources. However, this type of operation would help to mimic the natural river conditions that existed prior to the construction of the hydroelectric facilities, and thereby minimize the impacts caused by the hydropower system.

Although not recommended by a Federal, State, or local agency at this time, the review of natural river drawdown was requested by organizations during public scoping for this EIS. Consequently, natural river drawdown at the three dams (Wells, Rocky Reach, and Rock Island) has been evaluated for Alternative 2 at a brief summary level to help understand and compare its effect with other conservation measures. Although natural river drawdown is not an option under the existing FERC licenses, it may be considered during relicensing for the projects if requested by interested parties (2006, 2012, and 2028 for the Rocky Reach, Wells, and Rock Island dams, respectively).

It is uncertain whether drawdown to minimum operating pool (seasonal reservoir drawdown), which is an option under the current licenses, would result in an increase in juvenile survival in the Mid-Columbia River. Although smolt migration rates would likely increase, the correlation between migration speed and survival has not been consistently documented (Giorgi et al. 2002). Therefore, it was not evaluated in this EIS.

2.3.3.3 Committees

It is uncertain whether implementation of measures developed through Alternative 2 would be conducted through the existing, or similarly structured, coordinating committees. However, a coordinating committee similar to those currently operating is expected to occur under this alternative. Alternative 2 would therefore include coordinating committees likely consisting of representatives of the Joint Fisheries Parties and the PUDs. Decisions by the committees are expected to continue to be made by consensus.

2.3.3.4 Conservation Measures at the Projects, Including Hatchery Programs

Wells Hydroelectric Project

In 1990, the Douglas County PUD, the Wells Project power purchasers, resource agencies, and Tribes entered into a long-term fisheries settlement agreement for the Wells Project. This agreement established the Douglas County PUD's obligation for the installation and operation of juvenile downstream migrant bypass facilities, hatchery compensation for fish losses, and adult fishway operation. These measures, in conjunction with existing hatchery compensation programs, were considered to fulfil the Douglas County PUD's obligation to protect anadromous fish and mitigate and compensate for the effects of the Wells Project on anadromous fish.

Initial compensation was established at 14 percent until the PUD could implement juvenile survival studies to actually measure project impacts.

Recent measures undertaken by Douglas County PUD, consistent with the now expired biological opinion on the Wells Interim Protection Plan (NMFS 2000b), would likely continue to be incorporated into a long-term fish recovery plan. Additional measures may also be sought by NMFS if project operations are likely to jeopardize the continued existence of the listed species or cause the destruction or adverse modification of critical habitat, or if there is not adequate potential for recovery of listed species.

Similar measures may also be implemented for non-listed species, although these measures would be approved through provisions in the Federal Power Act instead of the Endangered Species Act. As a result, there is potentially a lower likelihood of implementing the same measures for species that are not currently threatened or endangered.

Measures currently anticipated to be part of the protection program include:

- 1. Adult Passage In addition to the measures described under Alternative 1 for Wells Dam:
 - a. Operate the surface bypass system during the upstream adult steelhead and springrun chinook migration periods and during the downstream kelt passage period to maximize the survival of fallbacks and downstream migrating adults.
- 2. Juvenile Passage In addition to measures described under Alternative 1 for Wells Dam:
 - a. Operate within 1 percent of peak turbine power efficiency at all times during the juvenile and adult passage periods, with appropriate reporting and monitoring requirements to ensure compliance.
 - b. Operate the surface bypass system 24 hours a day for up to 99 percent of the juvenile migration period.

- 3. Hatchery Program The same amount of chinook, sockeye, and steelhead would be produced as described under Alternative 1, although production could be reduced because of the potential negative effects of hatchery fish on naturally spawning populations of Endangered Species Act-listed fish. In addition, Douglas County PUD would fund the changes in hatchery procedures and evaluations needed to make the hatchery compensation program consistent with the Endangered Species Act recovery goals for listed spring-run chinook salmon and steelhead populations. However, because of the potential effects of hatchery fish on natural populations, and considering that project-related mortality is 3.8 percent rather than the assumed 14 percent, hatchery production would be reduced under Alternative 2. A similar reduction would also apply to yearling summer-run chinook salmon.
- 4. Monitoring and Evaluation Measures are the same as described under Alternative 1 for juvenile run timing, survival, total dissolved gas monitoring, and fish counting. The following additional measures are expected to be implemented:
 - a. Cumulative Effects In conjunction with NMFS, develop methodologies and conduct evaluations to assess the effects of passage through multiple dam systems on the fecundity, spawning success, and survival of adult spring-run chinook salmon and steelhead.
 - b. Evaluate adult fishladder passage standards as they relate to spring-run chinook salmon and steelhead, and modify facilities as needed.
 - Total Dissolved Gas Monitoring –
 Provide physical monitoring of total dissolved gas levels and temperature within the project area. Provide

biological monitoring to determine the incidence of gas bubble disease symptoms in adult salmon and steelhead.

5. Spill Program

- a. Maximize use of the spill program up to the maximum allowable total dissolved gas levels. At Wells, this would likely include spilling up to 40 percent of the daily average flow for up to 99 percent of the juvenile migration season for each salmonid species to maximize fish passage efficiencies and survival. The timing of spill would likely range from April through August.
- b. Limit spill to ensure compliance with the Ecology total maximum daily load (TMDL) allotment for total dissolved gas, which is up to 120 percent of saturation for the tailrace and 115 percent for the forebay of the project.

FERC and NMFS may require additional measures based on information obtained from monitoring and evaluation. This would include the need to protect any listed species from jeopardy under the Endangered Species Act.

Rocky Reach Hydroelectric Project

Long-term protection measures for the Rocky Reach Dam would likely be similar to those described in biological assessments submitted to NMFS and the subsequent biological opinion for the construction and operation of the permanent bypass system (NMFS 2002a). Additional measures might also be necessary if project operations are likely to jeopardize the continued existence of the listed species or cause the destruction or adverse modification of critical habitat (once designated), or if there is not adequate potential for recovery of listed species, based on additional information available to NMFS and as a result of continued monitoring and evaluation.

Similar measures may also be implemented for non-listed species, although these measures would be approved and implemented through provisions in the Federal Power Act instead of the Endangered Species Act. As a result, there is potentially a lower likelihood of implementing the same measures for species that are not currently threatened or endangered.

Measures currently anticipated to be part of the fish protection program include:

- Adult Passage In addition to the measures described under Alternative 1 for Rocky Reach:
 - Enhance the fishway entrance attraction conditions through planned operation of spill gates and turbines.
 - Investigate ladder modifications to improve operations within specified standards and minimize fish passage delay.
 - c. Provide safe downstream passage facilities for adult fallbacks and kelts (e.g., bypass system operations, spill).
 - d. Conduct modeling or other appropriate evaluations to determine the best actions for correcting passage problems, and implement measures as necessary.
- 2. Juvenile Passage Measures in addition to those described in Alternative 1 would include:
 - Construct a permanent juvenile bypass system to NMFS criteria that maximizes the non-turbine passage of anadromous salmonids (although included in Alternative 1 it is evaluated under Alternative 3).
 - b. Operate turbine units within 1 percent of peak turbine power efficiency at all times during the juvenile and adult fish passage

- periods, with appropriate reporting and monitoring to ensure compliance.
- Increase spill as necessary to maximize fish passage efficiencies and survival at the project.
- d. Implement measures to ensure that total dissolved gas levels are maintained below 120 percent of saturation under total river flows up to the 7-day 10-year peak flow event. The 120 percent saturation criterion is a special exemption that only applies when the dam is spilling water to aid the downstream migration of fish. At all other times, the criterion is 110 percent of saturation.
- e. Implement effective fish and avian predator control measures.
- f. Potentially implement additional or alternative juvenile bypass systems, such as a surface bypass sluiceway, to improve fish passage survival.
- 3. Hatchery Program The same amount of chinook and steelhead would initially be produced as described under Alternative 1, although production could be reduced at any time because of the potential effects of hatchery fish on natural populations. Hatchery production of non-listed species would not be changed unless the production levels are determined to affect the listed species. In addition, fund the changes in hatchery procedures and evaluations needed to make the hatchery compensation program consistent with recovery of spring-run chinook salmon and steelhead populations.
- 4. Monitoring and Evaluation In addition to those measures described under Alternative 1:
 - a. Cumulative Effects In conjunction with NMFS, develop methodologies and conduct evaluations to assess the effects

- of passage through multiple dam systems on the fecundity, spawning success, and survival of adult spring-run chinook salmon and steelhead.
- Survival Utilize the best techniques to estimate the survival of salmon and steelhead through the project. Techniques would likely include the use of PIT-tags for juveniles and radio-telemetry methodologies for adults.
- c. Total Dissolved Gas Monitoring Conduct physical monitoring of total dissolved gas levels and temperature within the project area. Conduct biological monitoring to determine the incidence of gas bubble disease symptoms in juvenile steelhead and salmon.
- d. Fish Counting Provide adult fish counts on a 24-hour basis.
- e. Evaluate adult fish passage efficiencies through radio-telemetry studies.
- f. Install adult PIT-tag detection devices in the adult fishways.

5. Spill Program

- a. Maximize use of the spill program for up to 40 percent of the daily average flow for up to 99 percent of the juvenile migration season for each salmonid species to increase juvenile fish passage survival at the project. The timing of spill may therefore range from April through August.
- b. Limit spill to ensure compliance with the Ecology total maximum daily load allotment for total dissolved gas, which is up to 120 percent of saturation for the tailrace and 115 percent for the forebay of the project.

FERC and NMFS may require additional measures based on information obtained from monitoring and evaluation. This would include the need to protect any listed species from jeopardy under the Endangered Species Act.

Rock Island Hydroelectric Project

Long-term protection measures for the Rock Island Dam would include:

- Adult Passage In addition to the measures described under Alternative 1 for Rock Island:
 - a. Provide safe downstream passage facilities for adult fallbacks and kelts (e.g., bypass system operations, spill, etc.).
 - Evaluate passage facilities through hydraulic evaluations and adult passage studies and correct problems when identified.
 - Investigate ladder modifications to improve operations within specified standards and minimize fish passage delay.
 - d. Conduct evaluations on spawning success and fecundity as it relates to passage through a multiple dam system.
- 2. Juvenile Passage Measures in addition to those described under Alternative 1 would likely include:
 - Construct a permanent juvenile bypass system to NMFS criteria that maximizes the non-turbine passage of juvenile salmonids.
 - b. Operate turbine units within 1 percent of peak turbine power efficiency at all times during the juvenile and adult passage periods, with appropriate reporting and monitoring to ensure compliance.

- c. Increase spill as necessary to maximize fish passage efficiencies and survival at the project.
- d. Implement measures to ensure that total dissolved gas levels are maintained below 120 percent of saturation under total river flows up to the 7-day 10-year peak flow event. The 120 percent saturation criterion is a special exemption that only applies when the dam is spilling water to aid the downstream migration of fish. At all other times, the criterion is 110 percent of saturation.
- e. Implement effective fish and avian predator control measures.
- 3. Hatchery Program The same amount of chinook and steelhead would initially be produced as described under Alternative 1, although production could be reduced because of the potential effects of hatchery fish on natural populations. Hatchery production of non-listed species would not be changed unless these production levels are determined to affect the listed species In addition, fund the changes in hatchery procedures and evaluations needed to make the hatchery compensation program consistent with recovery of spring-run chinook salmon and steelhead populations.
- 4. Monitoring and Evaluation In addition to those measures described under Alternative 1:
 - a. Cumulative Effects In conjunction with NMFS, develop methodologies and conduct evaluations to assess the effects of passage through multiple dam systems on the fecundity, spawning success, and survival of adult spring-run chinook salmon and steelhead.
 - Survival Utilize the best techniques to estimate the survival of salmon and steelhead through the project. Techniques

would likely include the use of PIT-tags for juveniles and radio-telemetry methodologies for adults.

- c. Total Dissolved Gas Monitoring –
 Provide physical monitoring of total
 dissolved gas levels and temperature
 within the project area. Provide
 biological monitoring to determine the
 incidence of gas bubble disease symptoms
 in juvenile salmon and steelhead.
- d. Fish Counting Provide adult fish counts on a 24-hour basis.
- e. Evaluate adult fish passage efficiencies through radio-telemetry studies.

5. Spill Program

- a. Maximize use of the spill program for up to 40 percent of the daily average flow for up to 99 percent of the juvenile migration season for each salmonid species. The timing of spill may therefore range from April through August.
- b. Limit spill to ensure compliance with total maximum daily load allotment requirements, which is up to 120 percent for the tailrace and 115 percent for the forebay of the project.

FERC and NMFS may require additional measures based on information obtained from monitoring and evaluation. This would include the need to protect any listed species from jeopardy under the Endangered Species Act.

2.3.3.5 Adaptive Management

Alternative 2 includes an adaptive management component through the Section 7 re-consultation process. Re-consultation would occur if new information becomes available that indicates that the provisions of the initial consultation were not adequate to ensure the continued existence of the

listed species. Re-consultations would also occur as a result of relicensing and license amendment processes, where FERC consults with NMFS prior to making a decision on proposed modifications of the project structures or operations or other plans that may affect listed species.

In addition, any actions that would substantially change conservation measures from existing conditions might have the potential for NMFS to request FERC to begin license reopener clause proceedings and prepare a biological assessment on listed species due to a change in project operations. Re-consultation would also occur if there were a change in species status, identification of a species critical habitat that occurs in the project area, or additional information related to project effects.

During re-consultation, NMFS would have the opportunity to adjust conservation measures, thereby providing an adaptive management process. However, there is some uncertainty of how effective this adaptive management process would be, given the potential implementation delays in the consultation process, and the project-by-project and issue-by-issue nature of the consultation process. This adaptive management would also involve just the listed species.

For unlisted species, adaptive management would involve the use of NMFS's Federal Power Act authorities to pursue additional protective measures in future relicensing or license reopener procedures or amendment proceedings. Adaptive management activities would also occur through the existing Mid-Columbia coordinating committees.

2.3.4 <u>ALTERNATIVE 3 (PROPOSED ACTION – PROJECT HCPs)</u>

The proposed action consists of implementing the three HCPs for the operation of the Wells, Rocky Reach, and Rock Island hydroelectric projects. The HCPs were developed to conserve and

protect listed and non-listed anadromous fish species over the long term, and to support ongoing compliance with the Endangered Species Act, while allowing continued operation of the three projects. The HCP fish protection measures and methodologies proposed to implement these measures would represent comprehensive longterm settlement agreements under the Endangered Species Act, the Federal Power Act, the Fish and Wildlife Conservation Act, the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act, the Northwest Power Planning and Coordination Act, and Title 77 RCW. Because the Agreements are comprehensive settlements, they propose a standard and scope greater than that required under the Endangered Species Act. The objective of the HCPs is to achieve percent no net impact for anadromous salmonids affected by the projects. This objective applies not only to the listed spring-run chinook salmon and steelhead, but also to the other anadromous salmonids in the Mid-Columbia River.

Protection for the migrating species is accomplished through a series of performance (survival) standards, which are based upon actual survival of the migrating species, not simply measures to be implemented regardless of their actual benefit to the migrating species. Unavoidable mortality is mitigated though tributary habitat improvements and state of the art hatchery supplementation.

The primary purpose of the HCP agreements is to obtain an incidental take permit from NMFS to comply with the Endangered Species Act for any take of listed anadromous fish as a result of project operations and satisfy the FERC relicensing requirement for the Plan species. Issuance of an incidental take permit is a Federal action subject to NEPA compliance. The purpose of NEPA is to promote analysis and disclosure of the environmental issues surrounding a proposed Federal action and to reach a decision that reflects NEPA's mandate to strive for harmony between human activity and the natural world. As a

cooperating agency, FERC also intends to utilize this EIS for subsequent licensing decisions (which are considered separate Federal actions), and the State agencies intend to use the information to satisfy state environmental requirements (SEPA).

The requirements of Section 10 of the Endangered Species Act provide the guidelines for HCP preparation. The information within each of the HCPs includes the following:

- the environmental setting in the project vicinity,
- structural and operational features of the project,
- existing operations related to anadromous salmonids.
- existing mitigation and monitoring measures and their effectiveness,
- unresolved issues related to anadromous salmonids (note: The 1998 Incidental Take Permit Applications indicated that there were unresolved issues at the time the applications were submitted. Unresolved issues were resolved by the amended applications filed in 2002. The HCPs address changing circumstances and unknown future events through committee processes and adaptive management [see Section 10.4.2 of the Wells HCP and Section 10.3.2 of the Rocky Reach and Rock Island HCPs].),
- proposed mitigation and enhancement measures to address unresolved and unknown future issues,
- proposed monitoring,
- costs and funding, and
- alternatives to the proposed measures.

In addition to Section 10 requirements, the issuance of an incidental take permit and amending a FERC license are Federal actions subject to Section 7 of the Endangered Species Act. Although Section 7 and Section 10 are similar, Section 7 introduces several considerations into the HCP process that are not explicitly required by Section 10. These considerations include the assessment of indirect effects, effects on Federally listed plants, and effects on critical habitat. As a result, NMFS and FERC are required to initially consult with the Services (NMFS and USFWS) to ensure that their actions proposed in the HCP are "not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification" of critical habitat.

2.3.4.1 HCP Species

The Plan species addressed in the HCPs are spring-run chinook salmon, summer/fall-run chinook salmon, sockeye salmon, coho salmon, and steelhead inhabiting the Upper Columbia River (Table 2-7) (see Section 13.19 of the Wells HCP and Section 13.20 of the Rocky Reach and Rock Island HCPs). In addition, the HCPs also identify Permit species (species covered under the incidental take permit application). The Permit species include all the Plan species except coho salmon. The native coho salmon populations have been extirpated from the Upper Columbia River, are not subject to Endangered Species Act protection, and therefore do not require the issuance of an incidental take permit.

Table 2-7. Plan and Permit Species Status, Relative to the HCPs (Alternative 3)

Species	ENDANGERED SPECIES ACT STATUS	EVOLUTIONARILY SIGNIFICANT UNIT	HCP STATUS
Steelhead	Endangered (August 1997)	Upper Columbia River	Plan and Permit Species
Spring-Run Chinook Salmon	Endangered (March 1999)	Upper Columbia River	Plan and Permit Species
Summer/Fall-Run Chinook Salmon	Not Warranted (March 1998)	Upper Columbia River	Plan and Permit Species
Sockeye Salmon	Not Warranted (March 1998)	Okanogan River	Plan and Permit Species
		Lake Wenatchee	
Coho Salmon	Extirpated	Upper Columbia River	Plan Species

2.3.4.2 HCP Term

The terms of the three HCPs and any incidental take permits are to be 50 years from the date the HCPs are executed (in the case of Chelan County PUD), and approved by FERC (in the case of Douglas County PUD) (see Section 1.1 in the Wells, Rocky Reach and Rock Island HCPs). In the event any PUD project is not relicensed to that PUD, the corresponding HCP for that project would terminate. A 50-year term was selected because it corresponds to the maximum length of a FERC license, although the HCP process will

not necessarily coincide with the FERC relicensing process at the three projects. A lengthy term is also appropriate because of the length of time and expense involved in negotiating and consulting on each of the HCPs. For example, the negotiation process for the three HCPs considered in this EIS began in 1993.

Although some HCP measures are currently being implemented by the PUDs, the HCPs would not be fully implemented until the agreements are executed by the signatory parties and the regulatory review processes have been completed. As a result, the effective date of the

agreements would be the later of when (1) FERC issues a final order approving and incorporating the agreements in the project licenses, (2) NMFS issues an incidental take permit, and (3) the USFWS completes the necessary consultation under the Endangered Species Act. Based on the current schedule, the terms of the HCPs should extend from approximately 2003 through 2053. Payments to the Plan species Account would be initiated 90 days after the effective date of each HCPs and adjusted for inflation from 1998.

The HCPs also have termination provisions if the performance standards are not achieved (see Section 1 of the Wells, Rocky Reach, and Rock Island HCPs). An HCP could be less than 50 years under the following circumstances:

- FERC issues a non-power license for the project,
- FERC orders removal or drawdown of the project, or
- if the no net impact standard has not been achieved or maintained by 2013 (2018 for the Wells Project), or if no net impact has been achieved and maintained but Plan species are not rebuilding and the project is a significant factor in the failure to rebuild,
- if a party fails to comply with the terms of the HCP,
- if the obligations imposed by the HCP are impossible to achieve,
- if NMFS revokes the incidental take permit, or
- if a regulatory entity takes action that materially alters or is contrary to one or more provisions of the HCP.

Any party to the HCP may elect to withdraw from the agreement at any time, based on the noncompliance provisions of the HCP agreements. However, NMFS and USFWS will not exercise their right to withdraw from the HCP until at least 2013 (2018 for the Wells Project) if the PUDs have complied with all aspects of the agreement but have not met the survival standards. If mutual agreement is reached between the PUDs and the two Federal agencies, the Services (NMFS and USFWS) can seek reservoir drawdown, dam removal, and/or non-power operations without withdrawing from the agreement or suspending or revoking the incidental take permit.

During the 50-year HCP term, all three projects would undergo a relicensing process with FERC. It is the intention of the HCPs that mitigation measures agreed to as part of the HCPs be consistent with, and form the basis of, subsequent FERC license articles developed to address impacts on anadromous salmonids. Therefore, unless the parties to the HCPs withdraw from the HCP agreements (following the prescribed withdrawal procedures), they would be supportive of a new license, under which the HCPs would constitute the terms, conditions, and recommendations for Plan species under Section 10(a), Section 10(j), and Section 18 Fishway Prescriptions in the new license (see Section 9.5 of the Wells HCP and Section 9.2 of the Rocky Reach and Rock Island HCPs).

The PUDs have voluntarily implemented some provisions of the HCPs because specific deadlines for reaching the survival standards were established in the HCPs. During this period, the PUDs have had the ultimate authority on pursuit and implementation of specific bypass measures since 1998. However, the existing FERC license articles, settlement agreements, and stipulations remain in effect to address dispute resolution proceedings, spill volumes, and hatchery compensation levels. Components of the HCPs that address each of these issues would not be implemented until the agreements have been ratified. To address ongoing Endangered Species Act issues, FERC issued an order approving the Rocky Reach Bypass System and NMFS issued a Biological Opinion for the Wells Project (which has since expired).

2.3.4.3 HCP Mitigation Objectives

All measures proposed in the HCPs are intended to minimize and mitigate impacts to the Plan species, to the "maximum extent practicable" as required by the Endangered Species Act. The HCPs also address the obligations of the PUDs under the Federal Power Act, the Fish and Wildlife Conservation Act, the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act, the Northwest Power Planning and Coordination Act, and Title 77 RCW (see Section 9.7 of the Wells HCP and Section 9.4 of the Rocky Reach and Rock Island HCPs).

The HCPs would mitigate impacts from dam operations in areas directly affected by those operations (project areas). The project areas extend from approximately 1,000 feet downstream of each dam (tailrace) to 1,000 feet downstream of the next dam upstream (reservoir). The PUDs would also provide funding for hatchery supplementation and tributary habitat improvement programs to offset losses not directly mitigated at the project.

2.3.4.4 HCP Performance Standards

The HCPs have specific performance standards that relate to the survival of each Plan species (see Section 4 of the Wells HCP and Section 5 of the Rocky Reach and Rock Island HCPs). The overall performance standard is to achieve no net impact to the Plan species through each dam. This term takes into account the fact that 100 percent equivalent survival cannot be achieved at the projects alone, requiring additional mitigation through off-site measures to increase salmonid productivity (e.g., hatchery supplementation programs and tributary habitat improvements).

The no net impact standard consists of two components:

1. A 91 percent combined adult and juvenile project survival rate achieved within the

- geographic area of the projects by fish passage improvement measures.
- 2. Compensation for the 9 percent unavoidable project mortality provided through hatchery and tributary programs, with compensation for 7 percent mortality provided through hatchery programs and compensation for the remaining 2 percent mortality provided through tributary habitat improvement programs.

It is the intention that these no net impact components will contribute to the rebuilding of tributary habitat production capacity and the basic productivity and numerical abundance of the Plan species. Tributary habitat improvement programs would involve the protection and restoration of salmonid habitat within the Columbia River watershed (from the Chief Joseph tailrace to the Rock Island tailrace), and the Okanogan, Methow, Entiat, and Wenatchee River Basins. The hatchery programs would be consistent with the objective of rebuilding naturally reproducing populations in their native habitats, while maintaining genetic and ecological integrity and supporting harvest.

Monitoring of both on-site and hatchery mitigation measures would be conducted, and mitigation measures would be modified, as necessary, to achieve or maintain the no net impact standard. A comprehensive evaluation of the hatchery mitigation program will be conducted to assess the effectiveness for achieving the no net impact standard in 2013, and every 10 years thereafter. Based on the results of these evaluations, adjustments could be made to the program. However, compensation for no more than 7 percent unavoidable project mortality would be provided through hatchery compensation without agreement of the parties that signed the HCPs.

Compensation for up to 2 percent unavoidable project mortality would be through tributary habitat improvements. This compensation level

is assumed, and will not be monitored for actual survival contribution during the 50-year term of the HCPs due to the difficulty and uncertainties associated with monitoring and quantifying the effects of tributary habitat improvements. However, a tributary assessment program will be funded to monitor and evaluate the relative performance of tributary improvement projects. The intent of this assessment program is to ensure the most cost effective and efficient use of the tributary improvement funds, but not to quantify the actual survival benefits.

The performance standards for the HCPs are the result of an extensive collaborative process dating back to 1993, and represent the collective wisdom and professional judgment of the scientists and regional policy makers participating in the process. In addition, the standards are generally consistent with the performance standards included in the 2000 Federal Columbia River Power System biological opinion for the Lower Snake and Columbia River projects (NMFS 2000c). In-river survival evaluations will be used to determine whether the survival standards are being achieved.

The no net impact and survival standards are designed to have several layers of requirements to provide the most flexibility in achieving and measuring the goal of recovering and stabilizing the anadromous fish runs in the Mid-Columbia River. In particular, although the 91 percent survival standard combines the adult and juvenile fish survival through the project, it is recognized that it is not currently possible to conclusively differentiate hydro-related mortality from natural adult fish losses. Therefore, the combined adult and juvenile survival standard will initially be measured through alternative survival measurements relative to juvenile fish passage. These alternative survival measurements assume a 2 percent adult mortality rate, based on the best available data throughout the region, which suggests a 98 to 100 percent survival rate of adults passing each hydroelectric project.

The alternative juvenile survival measurement was established to provide additional flexibility in estimating project impacts on each Plan species, given the species-related limitations of the available assessment techniques. The alternative metrics are for either juvenile project or juvenile dam passage survival. The alternative juvenile project passage survival metric is 93 percent (which is the survival rate over 95 percent of each Plan species migration through a project's reservoir, forebay, dam, and tailrace). This 93 percent survival goal includes direct, indirect, and delayed mortality, as it relates to the project, wherever it occurs and can be measured.

If juvenile project passage survival cannot be accurately measured, juvenile dam passage survival can be used as the next best alternative to determine if the HCP survival standards are met for each Plan species. The juvenile dam passage survival standard is set at 95 percent, and encompasses the survival of 95 percent of the juveniles passing through a project's forebay, dam, and tailrace areas. However, unlike the project survival standard, dam passage survival estimates do not include indirect or delayed mortality as they relate to project operations. Therefore, even if this standard is met, additional evaluations will be needed (as measurement technologies allow) to verify achieving the no net impact standard of the HCPs.

If neither of these alternative juvenile survival rates can be directly measured with the available technology, juvenile dam passage survival would be calculated based on the best available data (including the proportion of fish utilizing specific passage routes and estimated survival rates for each route). This calculation would consider the same elements as the directly measured juvenile dam passage survival technique, although off-site data may be used when project-specific data are not available. This calculation process could be used for Plan species such as sockeye and subyearling chinook because directly measuring dam passage survival for these species is currently not possible with existing technology.

The initial hatchery production levels are based on average adult returns and adult to smolt survival rated during a baseline period, and the need to compensate for up to 7 percent unavoidable project-related mortality. In response to requests from the Tribes, NMFS has agreed to fully permit the initial production levels identified in the HCPs through 2013. During 2013, and every 10 years afterward, the hatchery production levels would be evaluated and adjusted to achieve and maintain no net impact to each Plan species. These assessments would allow adjustments in production based on average adult returns and any changes in adult-to-smolt survival rate or smolt-to-adult survival rates for the hatchery production facilities. However, hatchery production levels established as compensation for original project inundation impacts are not subject to change.

In addition to hatchery program modifications based on the results of survival studies, there are procedures established to allow program reductions if the 7 percent hatchery compensation level is determined by NMFS to be inappropriate for species recovery. Such Endangered Species Act policy adjustments could occur in 2013 and every 10 years afterward, at the time of program reviews. Such policy changes might be required if the interactions of hatchery and wild fish are proven to be delaying the recovery process. These interactions include direct impacts such as competition for space and food, disease transmission, and predation.

Additional evaluations are expected over the next 10 years to determine the amount of hatchery supplementation that can be allowed without negatively impacting the listed species.

As part of the effort to achieve the performance standards, the PUDs would use their best efforts to evaluate, improve, maintain, and operate adult passage fishways to meet criteria established by the coordinating committees. The criteria currently used for the adult fishways were developed in cooperation with the existing Wells

Coordinating Committee, Rock Island
Coordinating Committee, and the Mid-Columbia
Coordinating Committee. The adult fishway
operating criteria for the Wells Dam can be found
in the Adult Fish Passage Plan (Appendix A) of
the Wells HCP. For Rocky Reach and Rock
Island, the adult fishway operating criteria is
referred to as the Detailed Fishway Operating
Plan (DFOP) (see Appendix A of the Rocky
Reach and Rock Island HCPs). The PUDs will
continue to maintain and operate the fishways
according to their respective criteria, or a
subsequent standard adopted by the HCP
coordinating committees.

Measures implemented at the projects to meet the performance criteria are referred to as "tools," which include any action, structure, facility, or program (on-site only) intended to improve the survival of Plan species migrating through the project areas.

Although there is limited survival information available for all the Plan species at each of the three dams, recent improvements in fish tagging technology (e.g., PIT-tags, miniature radio, acoustic and balloon tags) will provide more detailed and accurate future assessments.

The HCPs set an initial period for the PUDs to achieve the juvenile project or juvenile dam passage survival goals followed by up to 3 years of evaluation (see Section 4.2 of the Wells HCP and Section 5.3 of the Rocky Reach and Rock Island HCPs). The 3-year evaluation period has been completed by Douglas County PUD for yearling chinook and steelhead, while the first year of evaluation at Rocky Reach and Rock Island dams is scheduled to begin in 2004 and 2002, respectively. If the survival levels are not met, the HCP coordinating committees (which include NMFS participation) would then identify additional tools to implement, prior to the next migration period, to achieve the combined adult and juvenile, juvenile project or juvenile dam passage survival goals. Detailed discussions of

the evaluation phases are provided below in Section 3.2.2.6, HCP Phases.

2.3.4.5 HCP Phases

The HCP survival standards would be evaluated in three phases (see Section 4.2 of the Wells HCP and Section 5.3 of the Rocky Reach and Rock Island HCPs). During Phase I, the PUDs would evaluate survival rates for those Plan species that can be studied with existing methodologies. Juvenile fish survival studies would be measured at a 95 percent confidence level, with a standard error of no more than plus or minus 2.5 percent. However, if all testing protocols and model assumptions are adhered to, the coordinating committees can (by unanimous approval) accept study results with a standard error of plus or minus 3.5 percent.

Survival studies would be conducted over a 3year period to determine the survival rates. Study results that meet the precision and testing protocol requirements would be included in the 3-year average. Depending on the results of the 3-year survival studies, the PUDs would proceed to either Phase II or Phase III). The decisionmaking process for interpreting the survival study results is summarized in a decision matrix of the phase determination process (Figures 2-4 and 2-5). The juvenile survival studies conducted during Phase I could indicate that the standards were achieved for some species and not others. This would result in different phase designations for the various Plan species. The coordinating committees can also designate a representative or surrogate species for testing if the target species cannot be accurately tested with the existing technology.

If the Phase I evaluations conclude that the applicable survival standard has not been achieved, the PUD would enter Phase II (Interim Tools/ Additional Tools). In this phase, the coordinating committee would jointly decide on either interim tools or additional tools for the PUD to implement to achieve the pertinent

survival standard. Once implemented, up to 3 years of evaluations would be conducted to verify compliance with the standard and appropriateness of moving into Phase III. Until the survival standard(s) being measured are achieved, the PUDs will continue to implement either interim tools or additional tools to meet the standard(s). However, if it is determined that the standards cannot be met, the parties can withdraw from the HCP agreements. There are several determination levels under Phase III to address uncertainties or gaps in the available information. The coordinating committees would determine if the Phase III level has been achieved, at each project and for each Plan species, as follows:

- Standard Achieved Verified compliance with the 91 percent combined adult and juvenile survival standard or 93 percent juvenile project survival.
- Provisional Review Measured juvenile project survival less than 93 percent but greater than or equal to 91 percent.
- Additional Juvenile Studies Measured or calculated 95 percent juvenile dam passage survival.

Under Phase III (Standard Achieved), the PUDs would reevaluate survival every 10 years. These 1-year reevaluation processes would include one representative species for the spring migration period and another for the summer migration. The resulting survival estimates would be included in the cumulative average for those species. If the standard is no longer being achieved, additional evaluations would occur. If survival levels remain below the standards after 3 years of reevaluation, the PUD would move into

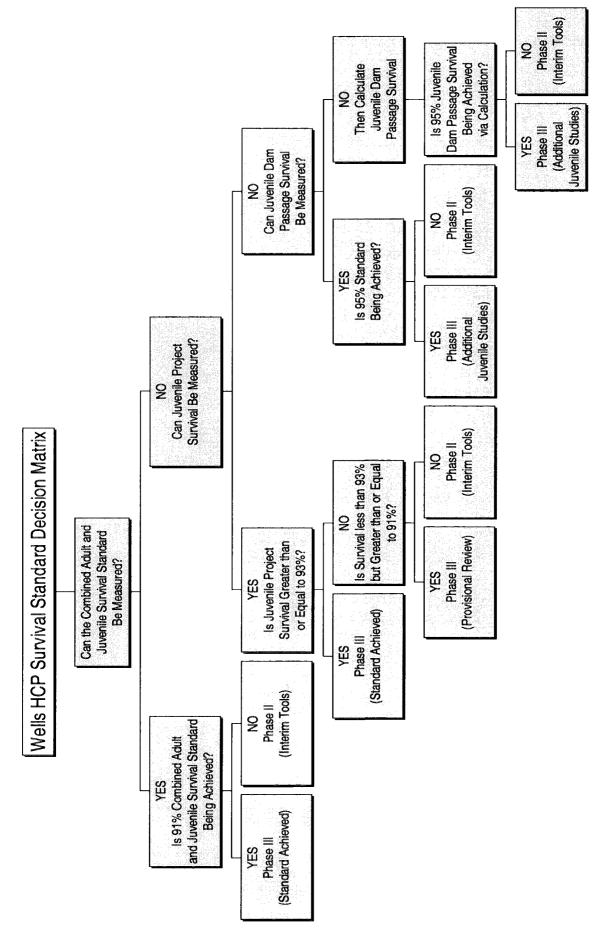


Figure 2-4. Wells HCP Survival Standard Decision Matrix

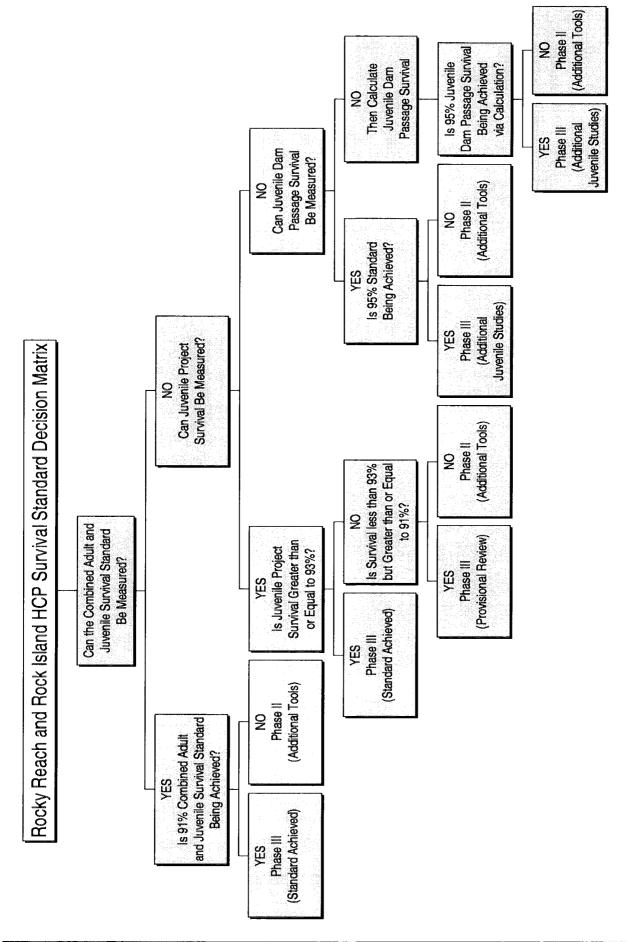


Figure 2-5. Rocky Reach and Rock Island HCP Survival Standard Decision Matrix

Phase II (Additional Tools) for that species, and follow the procedures discussed previously for Phase II. In addition, the coordinating committee would consider reevaluating other Phase III (Standards Achieved) species.

If the reevaluation studies show that the standards are being exceeded, the coordinating committees could make adjustments to the passage measures or the unavoidable mortality mitigation levels to maintain the no net impact standard. At Rock Island or Rocky Reach dams, the spill requirements could be adjusted for the following migration season used by that species, such that the survival standard is achieved but not exceeded. However, the survival standard could be exceeded for a particular species, if measures implemented primarily for another species provide additional survival benefits to both species. At Wells Dam, the coordinating committee could adjust the hatchery supplementation rates from the 7 percent level based on actual project survival, such that the no net impact standard is achieved but not exceeded.

A Phase III (Provisional Review) determination allows the PUD a one-time (Plan species specific) 5-year period to implement additional measures or conduct additional survival studies to achieve or verify the achievement of the pertinent survival standard. If the survival goal is subsequently met, the PUD would follow Phase III (Standard Achieved) or Phase III (Additional Juvenile Studies) procedures. If the pertinent standard cannot be achieved, Phase II (Interim Tools) procedures would be followed for Wells and Phase II (Additional Tools) would be followed for Rocky Reach and Rock Island. However, even if the juvenile dam passage survival rate (calculated or measured) is determined to be 95 percent or greater, Phase III (Additional Juvenile Studies) procedures would apply.

The Phase III (Additional Juvenile Studies) classification is provided because juvenile dam passage survival estimates do not address juvenile mortality in the reservoir. Therefore, even if the

95 percent juvenile dam passage survival (measured or calculated) is met or exceeded, either the 91 percent combined adult and juvenile project survival estimate or the 93 percent juvenile project survival metric would still be measured when appropriate monitoring methods are available.

Based on the survival and the fish passage efficiency studies, the parties to the HCP recognize that the Douglas County PUD has achieved the 93 percent juvenile project survival goal for yearling chinook and steelhead. In addition, the 95 percent juvenile dam passage survival goal is assumed to have been met for sockeye and subyearling chinook, until adequate evaluation methodologies are available to verify survival of these species.

For the Chelan County PUD, the evaluation period (Phase I) began at Rock Island in 2002 and would occur between 2004 and 2006 for Rocky Reach. The coordinating committees would use these evaluation results to make a phase determination for each Plan species.

Whenever Phase I evaluations indicate that the survival standards are not being achieved for a specific species, Phase II (Interim Tools) would be applied for the Wells Project and Phase II (Additional Tools) would be applied to the Rocky Reach and Rock Island projects. Phase II (Interim Tools) for Wells includes a set of project specific actions, that could be implemented at the project, to increase survival above the pertinent survival standard. Following the implementation of Interim Tools, an evaluation of the survival benefit of these actions will take place. For the Rocky Reach and Rock Island projects, the coordinating committees would identify the additional tools or studies that are to be implemented during Phase II. The coordinating committees shall use the following criteria when deciding which interim/additional tools to be implemented during Phase II. These criteria are:

1. likelihood of biological success;

- 2. time required to implement; and
- 3. cost-effectiveness of solutions, but only where two or more alternatives are comparable in their biological effectiveness.

The PUD would continue to implement Phase II tools for each Plan species that is not meeting the pertinent survival standard. The coordinating committee would determine the number of valid studies (not to exceed 3 years) necessary to verify the survival rate and make a phase determination, following the implementation of the interim/additional tools.

2.3.4.6 Dispute Resolution

The HCP agreements stipulate a dispute resolution procedure that would apply to all disputes over the implementation and compliance of the agreements (see Section 11 of the Wells, Rocky Reach, and Rock Island HCPs). These procedures rely on unanimous agreement of the pertinent coordinating committee representatives present for the dispute resolution process.

If a unanimous decision cannot be reached within a hatchery or tributary coordinating committees, then the dispute would be decided by the pertinent HCP coordinating committee. If the HCP coordinating committee cannot resolve a dispute elevated from the hatchery or tributary committee (or the HCP coordinating committee cannot resolve a dispute amongst themselves) then the dispute would be decided by a policy committee, comprised of executives of all signatory parties. If a unanimous decision of the attending representatives of the policy committee cannot be reached, each of the HCP parties may pursue any other right they might otherwise have to achieve their objectives. However, the agreement encourages the parties to seek a resolution through an alternative resolution process, including mediation or arbitration.

2.3.4.7 HCP Committees

The three HCPs would be implemented through a group of committees established for each project (see Section 6 of the Wells HCP and Section 4 of the Rocky Reach and Rock Island HCPs). Each project would have a coordinating committee, a tributary committee, and a hatchery committee.

The coordinating committees would oversee HCP monitoring programs, including the selection of the most appropriate survival standard to measure, protocols and methodologies to assess survival, and review of the study results to determine whether or not the survival standards have been achieved. The coordinating committee would also provide input on the choice of measures implemented under Phase I, and periodically evaluate and adjust the protection measures (after Phase I) to assess actual project survival and unavoidable project mortality.

Although adjustments can be made to ensure the no net impact standard, no more than 9 percent unavoidable project mortality shall be made up through hatchery and tributary compensation. If any project, for any species, cannot achieve the 91 percent combined adult and juvenile project survival, or 93 percent juvenile project survival, or 95 percent juvenile dam passage survival standard, then the PUDs shall consult with the signatory parties through the coordinating committees to jointly seek a solution. The committee would have the ability to select an independent third party to provide scientific review of any disputed survival study results.

The tributary committees are charged with the task of selecting projects and approving project budgets from the Plan Species Account for purposes of implementing the Tributary Conservation Plan.

The hatchery committees are responsible for evaluating the hatchery programs and ensuring that adequate compensation is being maintained based on the 7 percent compensation goal.

The tributary and hatchery committees would be formed after the HCP is approved by FERC, and would operate simultaneously and independently throughout the HCP terms.

2.3.4.8 HCP Conservation Plan and Compensation Measures

The measures described below are currently considered to be the tools that Chelan and Douglas County PUDs would use to meet 91 percent combined adult and juvenile project survival, or 93 percent juvenile project survival, or 95 percent juvenile dam passage survival.

Wells Dam

Outside of the existing mitigation measures negotiated during the 1990 long-term fisheries settlement agreement for the Wells Project (FERC 1991), no new structural modifications have been identified to date. The combination of the existing juvenile fish bypass system at Wells Dam and the replacement of the turbine units with minimum gap type turbines has produced a 3-year average project survival of 96.2 percent for yearling chinook and steelhead.

As a result, the HCP signatory parties have determined that Douglas County PUD has achieved the Phase III (Standard Achieved) designation for yearling chinook and steelhead. The HCP parties also believe that the calculated estimate of juvenile dam passage survival for sockeye and subyearling chinook is probably greater than the 95 percent standard and that Douglas County PUD has most likely achieved Phase III (Additional Juvenile Studies) for subyearling chinook and sockeye.

Based on the measured or calculated survival information, the juvenile bypass system would continue to be operated in a manner consistent with that used during the evaluation phase (see Section 4.3 of the Wells HCP). Specific

measures to be implemented include the following:

- Continuously operate the bypass between April 10 and August 15, or longer if necessary to encompass 95 percent of a juvenile migration period.
- Coordinate with the HCP signatory parties and other resource agencies to address total dissolved gas and other water quality issues.
- Maintain effective predator control measures consisting of northern pikeminnow removal and piscivorous bird harassment and control measures. The northern pikeminnow removal program may include a pikeminnow bounty program, fishing derbies/tournaments, and the use of long-line and fish trapping methods. Piscivorous birds, including Caspian terns, double-crested cormorants, and various gull species, would be hazed. Hazing techniques include elaborate wire arrays in the tailrace to deter foraging, propane cannons, various pyrotechnics, and lethal control when necessary. The program would be implemented during the juvenile fish outmigration periods.
- Operate and maintain the adult fish passage systems according to procedures outlined and criteria developed through the coordinating committee, and use best efforts to eliminate identified sources of adult injury and mortality while passing the project.
- Evaluate the biological significance of adult fallback rates and steelhead kelt loss at the project, and implement recommendations of the coordinating committee likely to significantly improve survival.

Rocky Reach Dam

The Chelan County PUD would be undertaking various interim, prototype, and permanent measures at the Rocky Reach Project in an effort

to achieve the 91 percent combined adult and juvenile project survival, or 93 percent juvenile project survival, or 95 percent juvenile dam passage survival standards. These measures would include interim spill, bypass diversion screen operations, surface collection bypass system construction and evaluation, turbine replacement, and predator control (see Section 5.4 of the Rocky Reach HCP). The appropriate mix of measures would vary as the surface collection system is improved and its efficiency tested and quantified.

Phase I testing at Rocky Reach Dam is expected to begin in 2004 for yearling chinook and steelhead. The surface collection juvenile bypass system is scheduled to be completed by 2003. Chelan County PUD will use the 2003 juvenile outmigration season to conduct studies to identify specific physical or operational modifications prior to the first year of survival testing (2004). Based on the results of these initial studies, spill levels will be adjusted for the Phase I testing period (2004 – 2006). Survival rates for subyearling chinook and sockeye would be measured if technology exists, or calculated based on estimated survival rates for, and the proportion of these species passing, each passage route at the project.

Survival data would determine the number, type, and magnitude of the various protective measures needed to achieve the 91 percent combined adult and juvenile project survival, or 93 percent juvenile project passage survival, or 95 percent juvenile dam passage survival standards. Actions would also be taken to improve survival and ensure timely passage of adult anadromous salmonids through the project. The following measures would be implemented:

 Install a juvenile fish bypass system consisting of a surface collection system with secondary collection from a limited number of turbine intake screens.

- Continuously operate the bypass between April 1 and August 31, or longer if necessary to encompass 95 percent of a juvenile migration period.
- Modify replacement turbine runners to improve survival of juvenile anadromous salmonids as much as possible, given manufacturing, technical, and installation schedule limitations.
- Continue implementing a spill program that provides spill levels to achieve 95 percent survival when used with the surface collector during a period encompassing 95 percent of migration periods of spring- and summer-migrating Plan species. In addition, provide 25 percent spill during the Okanogan sockeye outmigration period (for up to a maximum of 21 days). Spring spill would begin no later than April 20 and generally end no later than June 15. The summer spill period is between July 1 and August 15.
- Coordinate with the HCP parties and other resource agencies to address total dissolved gas and other water quality issues.
- Maintain effective predator control measures consisting of northern pikeminnow removal and piscivorous bird harassment and control measures. The northern pikeminnow removal program may include a pikeminnow bounty program, fishing derbies/tournaments, and the use of long-line and fish trapping methods. Piscivorous birds, including Caspian terns, double-crested cormorants, and various gull species, will be hazed. Hazing techniques include elaborate wire arrays in the tailrace to deter foraging, propane cannons, various pyrotechnics, and lethal control when necessary. The program would be implemented during the juvenile fish outmigration periods.
- Operate and maintain the adult fish passage systems according to criteria developed

through the coordinating committee, and use best efforts to eliminate identified sources of adult injury and mortality while passing the project.

- Evaluate the biological significance of adult fallback rates and steelhead kelt loss at the project, and implement recommendations of the coordinating committee likely to significantly improve survival.
- Perform the necessary studies to properly monitor and evaluate on-site mitigation measures.

Rock Island Dam

Similar to the Rocky Reach Project, the Chelan County PUD would undertake various interim, prototype, and permanent measures at Rock Island Dam in an effort to achieve the 91 percent combined adult and juvenile project passage survival, 93 percent juvenile project passage survival, or 95 percent dam passage survival standards for juvenile anadromous salmonids.

The HCP identifies several specific measures to implement at Rock Island Dam to improve fish passage survival (see Section 5.4 of the Rock Island HCP). One measure is to replace the existing Fisheries Conservation Account spill program with a program that provides spill levels of 20 percent of the daily average flow during a period encompassing 95 percent of the migration period for each Plan species. Under this new program, spring spill would begin no later than April 17 and generally end no later than June 15. The summer spill period is between July 1 and August 15. However, spill periods can be extended to encompass 95 percent of the migration period for each Plan species. The fish migration periods will be determined by fish captured in the second powerhouse juvenile fish bypass system.

Another measure outlined in the HCP is to maintain effective predator control measures

consisting of northern pikeminnow removal and piscivorous bird harassment and control measures. The northern pikeminnow removal program may include a pikeminnow bounty program, fishing derbies/tournaments, and the use of long-line and fish trapping methods. Piscivorous birds, including Caspian terns, double-crested cormorants, and various gull species, will be hazed. Hazing techniques include elaborate wire arrays in the tailrace to deter foraging, propane cannons, various pyrotechnics, and lethal control when necessary. The program would be implemented during the juvenile fish outmigration periods.

The PUD would also operate and maintain the adult fish passage systems according to criteria developed through the coordinating committee, and use best efforts to eliminate identified sources of adult injury and mortality while passing the project. The HCP also stipulates the evaluations of the biological significance of adult fallback rates and steelhead kelt loss at the project, and implementation of the coordinating committee recommendations likely to significantly improve survival.

Other measures could include a juvenile bypass system, modified spill gates for surface spill, continued or expanded measures for predator control, and possible improvements to turbines. Survival data obtained at each step in the process would determine the number, type, and magnitude of the various protective measures needed to achieve the pertinent survival standard. Actions would also be taken to improve survival and ensure timely passage of adult anadromous salmonids through the project to meet the 91 percent combined adult and juvenile project survival standard. Some or all of the following measures would be implemented:

 designing, modeling, prototype testing, and installing spill gate modifications to provide surface spill to increase fish passage efficiency;

- testing and evaluating various spill configurations;
- designing, modeling, prototype testing, and installing a turbine bypass system consisting of a surface bypass collection system, with or without secondary collection from turbine intakes;
- replacement of turbine runners to improve survival of juvenile anadromous salmonids that pass through the units, and limiting use of the Powerhouse 1 turbines;
- testing a forebay guidance curtain to route juvenile anadromous salmonids into surface bypass collectors;
- maintaining effective predator control measures; and
- performing necessary studies to properly monitor and evaluate on-site mitigation measures.

Tributary Conservation Plan

Alternative 3 would create a Plan Species Account, to be used to fund activities for the protection and restoration of Plan species habitat within the Columbia River watershed (from Chief Joseph tailrace to the Rock Island tailrace), and the Okanogan, Methow, Entiat, and Wenatchee River watersheds, to compensate for the unavoidable 2 percent project mortality (see Section 7 of the Wells, Rocky Reach and Rock Island HCPs).

Restoration projects would occur within one of seven categories: (1) habitat protection, (2) floodplain rehabilitation, (3) channel function, (4) instream flow improvements, (5) fish passage improvements, (6) riparian restoration, and (7) water quality improvements. These habitat improvement projects could include, but are not limited to:

- providing access to currently blocked stream sections or oxbows,
- removing dams or other passage barriers on tributary streams,
- improving or increasing the hiding and resting cover habitat that is essential for these species during their relatively long adult holding period,
- improving in-stream flow conditions by correcting problematic water diversion or withdrawal structures, and
- purchasing important aquatic habitat shoreline areas for preservation or restoration.

Such tributary habitat conservation and restoration measures are expected to improve the migration and rearing conditions for all anadromous fish species, as well as other resident fish. These measures are also expected to help decrease bank erosion, sedimentation, channel scouring, and water quality problems. The improved conditions would increase the opportunities for successful spawning by facilitating the return of adult anadromous salmonids to their natal spawning areas at the proper time and in good health. The tributary committees would review all habitat restoration projects according to the criteria set forth in the HCP supporting documents provided as appendices to the HCPs.

The funding levels for each project to the Plan Species Account are set in the HCPs. The combined total contributions through the 50-year term of the HCPs will be over \$46.5 million in 1998 dollars. For the Wells Project, the Douglas County PUD would fund an initial contribution to the account of \$1,982,000 (1998 dollars adjusted for inflation). Five years after the initial contribution, the PUD could either provide annual payments of \$176,178 (1998 dollars) throughout the HCP term or provide an up-front payment of \$1,761,781 (equivalent to 10 yearly payments in

1998 dollars), deducting the actual costs of bond issuance and interest. After a total of 15 years, the HCP parties would determine the contribution method of the remaining funds (at a rate equivalent to \$176,178 per year).

These funding levels are based on a 2 percent mitigation level for adult mortality. However, if the adult passage survival is determined to be greater than 98 percent and the juvenile project passage survival is greater than 93 percent, for any one of the Permit species, contributions to the Tributary Fund would be reduced to reflect the actual adult survival estimate of that species.

The adult survival estimates for each Permit species would independently determine one quarter of the funding to the Plan Species Account for each project. For example, if adult steelhead and spring-run chinook salmon survival were determined to be 99 percent, the annual contributions to the Plan Species Account would be based on 1 percent mortality for these two species. However, the annual contributions for the other two Permit species would continue to be based on a 2 percent mitigation level. Under this scenario, the annual contributions to the account would be reduced from a full 8/8th contribution (2 percent for four species) to a 6/8th contribution.

For the Rocky Reach Project, Chelan County PUD would fund the Plan Species Account at \$229,800 annually (1998 dollars adjusted annually for inflation) for the term of the HCP. At the request of the tributary committee, advanced contributions would be made during the first 15 years of the agreement.

For the Rock Island Project, the Chelan County PUD would provide \$485,200 annually (1998 dollars adjusted annually for inflation) to the Plan Species Account. At the request of the tributary committee, advanced contributions would be made during the first 15 years of the agreement.

The Plan Species Account would be vested with the authority to expend money contributed by the PUDs for activities within the Columbia River watershed (from Chief Joseph Dam tailrace to the Rock Island tailrace), and including the Okanogan, Methow, Entiat, and Wenatchee River watersheds to increase productivity of anadromous salmonids in the Mid-Columbia River area.

The tributary committee would be composed of one representative of each of the signatory parties. The committee may select other expert entities, such as land and water trust/conservancy groups, to serve as additional, non-voting members of the tributary committee. The committee would be charged with the task of selecting projects and approving project budgets for the purposes of implementing the Tributary Conservation Plan.

The tributary habitat improvement projects would be determined on a case-by-case basis by the tributary committee, subject to the guidelines and standards of biological and economic efficiency and the financial resources of the Plan Species Account. The guidelines for tributary projects place the highest priority on maintaining and improving stream channel diversity and floodplain function. The projects would seek to conserve and protect riparian habitat to improve incubation and rearing conditions in tributary streams.

Through the Tributary Assessment Program, the PUDs would provide support for assessing the relative merits of each tributary project funded (see Section 7.5 of the Wells, Rocky Reach, and Rock Island HCPs). Funding for the assessment program is separate from the Plan Species Account, but is set for approximately \$200,000 per project (up to \$600,000 for all three projects) (not subject to inflation adjustment) during the term of the HCPs.

Hatchery Compensation Plan

Each hatchery committee would consist of one representative of each HCP signatory party.

These committees would direct the effort required of each PUD to meet the 7 percent hatchery compensation goal to achieve no net impact for each Plan species. The initial estimated HCP hatchery production capacities for each Plan species was based on the average adult returns of that species for a baseline period, the 7 percent compensation level, and baseline adult/smolt survival rates for existing Mid-Columbia River hatcheries (see Section 8 of the Wells, Rocky Reach, and Rock Island HCPs).

The estimated production capacity shall be adjusted periodically, excepting for original inundation mitigation, to achieve and maintain no net impact to the Plan species. Adjustments to the hatchery compensation level may include reduction of production to conform to actual project mortality, as determined from monitoring and evaluation, or increases in production as the base population level increases in the recovering anadromous fish populations. Hatchery compensation may be increased either by increasing the number of fish produced or by increasing the survival of fish produced at the initial production levels. Such adjustments would be based on the results of juvenile passage survival evaluations at the hydroelectric projects.

Until successfully reproducing coho salmon populations are reestablished, or a long-term coho hatchery program is developed, there are no hatchery compensation programs required in the HCPs for coho salmon.

2.3.4.9 Provisions for Unknown Impacts on Other Aquatic Species

The HCPs do not include mitigation measures for non-Plan species. However, species that actively or passively pass the project (such as bull trout) may benefit from improvements at the dams (through improved fish passage conditions). Bull trout are a threatened species in the Columbia River Basin, and although they occur in the project area, the extent of their occurrence and the

project-related impacts are largely unknown. The PUDs and FERC are currently conducting informal consultation with the USFWS to assess the potential effect of project operations on bull trout.

Aquatic species that are expected to benefit from the tributary habitat improvement projects conducted under the HCPs are Pacific lamprey and resident trout species (including bull trout) that occupy the same habitats as the Plan species.

Terrestrial wildlife species that use riparian, wetland, and floodplain habitats are expected to benefit from implementation of aquatic habitat improvements in the tributaries. These improvements should increase their food supply, cover, and overall habitat area.

2.3.4.10 Monitoring and Evaluation

All three HCPs propose monitoring and evaluation of on-site measures to determine if the 95 percent juvenile dam passage survival, the 93 percent juvenile project passage survival, or the 91 percent combined adult and juvenile project passage survival metrics have been achieved (see Section 4 of the Wells, Rocky Reach and Rock Island HCPs). In addition, monitoring and evaluation of tributary habitat improvements funded by the Plan Species Account and the number and effects on other species after release of fish produced by the hatchery program would also be monitored.

2.3.4.11 Project Cumulative Effects

The anadromous salmonid mortality rates associated with passage at the projects contribute to the overall mortality of the Plan species passing other downstream hydroelectric projects. However, the salmonid survival improvements resulting from the proposed actions would be in addition to other recovery efforts underway in the basin. The primary recovery efforts include the reasonable and prudent measures identified in the

FCRPS biological opinion, Water Resource Inventory Area planning efforts, Salmon Recovery Funding Board activities, and the extensive predator control activities underway within the Columbia River Basin.

The PUDs would consider the cumulative impact effects when making land use decisions on project-owned lands to meet the conservation objectives of the HCPs, FERC license requirements, and other applicable laws and regulations. The PUDs would notify and consider comments from the signatory parties regarding land use permit applications on project-owned lands. The PUDs would also notify applicants seeking permits to use or occupy project lands or water that such use or occupancy may result in an incidental take of species listed under the Endangered Species Act, requiring advance authorization from NMFS or USFWS.

The run-of-the-river Mid-Columbia River PUD projects have limited capabilities for storing water, and are therefore unlikely to affect water quantity parameters. However, the cumulative impacts of the projects include water quality issues, particularly the effects on temperature and total dissolved gas. The PUDs would continue to work cooperatively with each other, and other entities in the region, to minimize the cumulative effects of project operations on water quality issues.

Project operations could have an effect on recreation, riparian vegetation, and wildlife species along the mainstem Columbia River, particularly for drawdown options. With the general exception of drawdown options however, project operations are not expected to substantially affect these or the other resources analyzed in this EIS, compared to existing conditions.

Off-site tributary enhancement projects could affect all the resources addressed in the EIS, depending on the location and the extent of the projects. Although such changes are expected to

have environmental benefits, the effects to resources other than anadromous fish species would likely be minimal. The tributary habitat improvement projects could affect land ownership, if riparian habitat corridors are purchased or leased as mitigation activities. Other habitat improvement projects are likely to require various permits or environmental reviews.

2.3.4.12 Costs and Funding

Funding of all PUD obligations, including studies necessary to evaluate and monitor the effectiveness of those measures, would be provided directly by the PUDs from power sale revenues. It is anticipated that bonds secured by those revenues would be issued for major capital costs, such as bypass construction. Money for the Plan Species Account and the Tributary Assessment Program would also come from project revenues, with the initial contribution possibly obtained from a bond issue (see Section 7.4 of the Wells HCP and Section 7.5 of the Rocky Reach and Rock Island HCPs).

2.3.4.13 Verification of Standards

To determine if the HCPs' survival standards are being met, specific biological and statistical standards have been established in the HCPs (see Section 4.1.4 of the Wells HCP and Section 5.2.3 of the Rocky Reach and Rock Island HCPs). These standards apply to all of the evaluations to be conducted. The results would be utilized to support decisions made after Phase I of the HCPs. Efforts to determine more direct evidence of compliance with the HCP standards for all Plan species would continue during Phases II and III.

Because the juvenile fish passage survival standards cannot be verified for subyearling chinook (summer/fall chinook) or for sockeye salmon, and the 91 percent combined juvenile and adult project survival standard cannot be verified for any of the Plan species, compliance

with the juvenile dam passage survival standards would be based on calculations.

Survival studies of yearling chinook salmon and steelhead were initiated at the Wells Project in 1998 and were initiated at Rock Island Dam in 2002. Survival studies will be initiated at the Rocky Reach Dam no later than 2004. Initial verification of the 93 percent juvenile project passage or 95 percent juvenile dam passage survival standards is expected to take 3 years.

The HCPs provide a mechanism for future verification of the 91 percent combined juvenile and adult project survival standard for each of the Plan species, as the appropriate technology is developed and supported by the coordinating committees.

Wells Project

Because the Wells Project has an existing bypass system, juvenile survival studies were initiated earlier than at the other projects. Douglas County PUD conducted juvenile survival studies in 1998 using yearling chinook salmon, and in 1999 and 2000 using yearling steelhead. These studies met the biological and statistical standards established in the revised HCPs. Additionally, the Douglas County PUD conducted 3 years of fish passage efficiency evaluations (an estimate of the number of juvenile fish bypassing the project powerhouse through the surface bypass system) for the Wells Project bypass system.

The 3-year average from the yearling chinook and steelhead project survival studies was 96.2 percent. The 3-year average for the fish passage efficiency studies indicates that 92 percent of the spring-run migrants (yearling chinook, steelhead, and sockeye) and 96 percent of the summer-run migrants (summer/fall chinook) use the bypass system. Based on the best estimate of turbine and bypass system survival (90 to 93 percent and 98 to 99 percent, respectively), spring-run migrants are expected to have a juvenile dam passage survival rate of 97 to 98 percent and summer-run

migrants are expected to have a 97 to 98 percent juvenile dam passage survival rate.

Throughout the term of the HCP, the 93 percent juvenile project passage survival, the 95 percent juvenile dam passage survival standard, or the 91 percent combined adult and juvenile project survival standard would be reevaluated every 10 years. It is anticipated that survival studies would be conducted for sockeye and subyearling chinook salmon, as well as adult salmon and steelhead, as technology is developed.

Funding for the Wells Tributary Conservation Plan is tied directly to the fish passage survival standard. If it is determined that the Wells adult survival rate for an individual Plan species is equal to or greater than 98 percent and the juvenile project passage survival is greater than 93 percent, the funding of the Tributary Conservation Plan would be reduced to reflect adult survival estimates for that species.

Rocky Reach Project

The Chelan County PUD is developing a surface bypass collector system for the Rocky Reach Project. This system is expected to be installed by the 2003 spring outmigration period, while survival tests would not start until 2004. Chelan County PUD would initiate 3 years of survival studies for yearling chinook salmon and steelhead to verify that the 93 percent juvenile project passage survival or the 95 percent juvenile dam passage survival standard is being met. The best available information would be used to determine whether the juvenile passage survival standards have been met for each of the remaining Plan species (e.g., survival information from surrogate species combined with measurements of fish passage through non-turbine routes). Throughout the term of the HCP, the pertinent survival standard would be reevaluated from time to time as determined necessary by the coordinating committee.

Rock Island Project

Spill is currently the preferred juvenile bypass measure at Rock Island Dam. Beginning in 2002, Chelan County PUD would initiate 3 years of survival studies for yearling chinook salmon and steelhead to verify that either the 93 percent juvenile project passage survival or the 95 percent juvenile dam passage survival standard is being met. As is the case with the Wells and Rocky Reach projects, the best available information would be used to determine the juvenile passage survival for each of the remaining Plan species (e.g., survival information deemed sufficient by the HCP coordinating committee could be combined with measurements of fish passage through non-turbine routes to develop interim estimates of dam passage survival). Throughout the term of the HCP, the pertinent survival standard would be reevaluated from time to time as determined necessary by the coordinating committee.

2.3.4.14 Compensation for Unavoidable Project Mortality

During the development of this EIS, certain sections of the HCPs required clarification to allow for accurate analysis of the potential effects of the actions on Endangered Species Act-listed species and on other natural resources. Most of the clarifications related specifically to modification of the standards to ensure no net impact. It should be noted that HCP survival standards are fixed and compensation would not increase if the standards are not being met. For example, hatchery compensation would not be increased to 9 percent if juvenile dam passage survival were measured at only 93 percent for a given species. The 2 percent shortcoming in the juvenile dam passage survival standard would need to be addressed through improvements in dam passage survival. Likewise, if the 7 percent hatchery compensation level is not met due to NMFS Endangered Species Act concerns, neither the dam passage survival standard, the project

survival standard, nor the habitat compensation standard would be adjusted. However, failure to meet the standards by 2013 (2018 for the Wells Project) would allow parties to withdraw from the HCP agreements.

Although the compensation levels would not increase as a result of not meeting the survival standards, hatchery compensation for the Wells Project could be reduced if the survival standards are exceeded. However, if the survival standards are exceeded at Rock Island or Rocky Reach dams, Chelan County PUD may reduce the amount of spill to levels which will continue to meet the survival standards of the HCPs, as indicated by an additional series of survival studies.

2.3.4.15 Hatchery Compensation Plan Issue

During the development of the HCPs, NMFS determined that the 7 percent hatchery compensation levels may adversely affect wild salmon populations under certain conditions.

Therefore, until the specific details of the compensation programs were developed (including identification of appropriate broodstock, maximum percentages of the wild populations that can be trapped for broodstock, and the total number of fish produced through artificial means), NMFS could not guarantee that the 7 percent compensation level would satisfy Endangered Species Act requirements.

Although several of the affected Columbia Basin Treaty Tribes made significant comments during the scoping process associated with this EIS, a major concern was NMFS's reluctance to guarantee the 7 percent compensation levels. These levels were a key component of achieving and maintaining no net impact and an important Tribal consideration for maintaining their treaty rights under the conditions of the HCPs. The inability of NMFS to guarantee the 7 percent hatchery compensation levels, under all

circumstances, led to a breakdown in the negotiation process between the parties. Without this guarantee, as well as other assurances concerning Tribal treaty rights, the Yakama and Umatilla Tribes would not endorse the HCPs. To address the Tribes' concerns regarding hatchery production levels, subsequent HCP negotiations resulted in an agreement to provide the PUDs with a 7 percent hatchery production guarantee through 2013. In 2013 the parties to the HCP agreements shall have an opportunity to review and make modifications to the hatchery compensation component of the HCP agreements. Based on the results of the program review in 2013, the program could be changed at that time, or in subsequent reviews scheduled for every 10 years.

To minimize the potential impacts to wild fish from the Hatchery Compensation Plans, the PUDs would implement specific elements of the hatchery program consistent with overall objectives of rebuilding natural populations, and achieving no net impact to the Plan species. Specific objectives may include contributing to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecologic integrity, and supporting harvest objectives.

For example, the Douglas County PUD would alter its sockeye compensation program, which currently raises spring-run chinook as a substitute species. After 2005, sockeye mitigation would be accomplished by implementing a set of options identified in the Sockeye Enhancement Decision Tree (Section 14, Figure 3 of the Wells HCP). The initial focus of this program is funding the implementation of a Canadian Flow Management Program. The flow management program is designed to incorporate current knowledge about biological and physical processes controlling sockeye salmon production into a set of water management models. The models would be used to make "fish friendly" water management decisions in the Canadian portion of the Okanogan River system. The goal of this

program is to enhance natural sockeye production, instead of funding artificial production programs.

Due to the increased emphasis on developing hatchery programs that focus on rebuilding natural populations, NMFS believes (pending completion of its review of the HCPs) that the initial hatchery production levels outlined in the HCPs are unlikely to jeopardize the continued existence of the listed species in the near term. However, there is still some uncertainty over the long term. As a result, it was agreed that the initial hatchery production levels necessary to compensate for 7 percent unavoidable mortality at the projects would be maintained until a comprehensive review is conducted in 2013. (Chelan County PUD hatcheries are compensating for a 14 percent juvenile mortality in the period running through 2013.) These production levels are based on adult return rates during the baseline period, the 7 percent compensation requirement, and baseline adult to smolt survival rates for existing Mid-Columbia River hatcheries. In addition to the program review in 2013, additional reviews would occur every 10 years during the term of the HCPs.

2.3.4.16 Other Options Considered

Similar to Alternative 2, Alternative 3 could include project reservoir drawdown after 2013 for the Rocky Reach and Rock Island projects or after 2018 for the Wells Project. Either the USFWS or NMFS could pursue this option under certain circumstances, including if: (1) no net impact has not been achieved or has been achieved but has not been maintained, (2) the Plan species are not rebuilding and the project is a significant factor in the failure to rebuild, or (3) is agreed to by the PUDs.

2.3.4.17 Recent HCP Policy Revisions

On June 1, 2000, USFWS and NMFS published a final addendum to the *Habitat Conservation*

Planning and Incidental Take Permit Processing Handbook (USFWS and NMFS 2000). This addendum, which is also known as the five-point policy guidance, provides clarifying direction on five issues brought forth from recent HCPs implemented throughout the United States. The following sections describe how the applicant HCPs meet the HCP addendum.

Biological Goals and Objectives

The addendum recommends that biological goals and objectives be incorporated in HCPs. These goals may be either habitat- or species-based. Species-based goals are expressed in terms specific to individuals or populations of that species. The performance standards represent the biological goals and objectives for the HCPs (i.e., the HCP standards). These standards require specific survival goals based on the population passing through each project. In addition, incidental mortality is mitigated through hatchery production and habitat improvements to achieve an overall no net impact standard.

Adaptive Management

The use of an adaptive management strategy is recommended to (1) identify uncertainties related to quantifying the achievement of goals and objectives of the HCPs, as well as the questions that need to be addressed to resolve these uncertainties; (2) develop alternative strategies and determine which experimental strategies to implement; (3) integrate a monitoring program that is able to detect the necessary information for strategy evaluation; and (4) incorporate feedback loops that link implementation and monitoring to a decision-making process that results in appropriate changes in management. Adaptive management would be incorporated into the HCP monitoring programs that provide the feedback necessary to determine the effectiveness of various approaches being implemented to

increase fish survival. Throughout the term of the HCP, what is learned would be used to adjust conservation measures.

Monitoring

HCP handbook guidance on monitoring recommends that the monitoring program reflect the measurable biological goals and objectives. The monitoring programs developed under the Mid-Columbia River HCPs are three-fold: (1) confirm fish survival through the dams (validation monitoring), (2) evaluate the effectiveness of on-site mitigation measures implemented to improve fish survival (effectiveness monitoring), and (3) confirm that the on- and off-site mitigation measures are applied correctly (implementation monitoring).

Permit Duration

Factors to be evaluated when determining permit duration include the time line of the proposed activities and the expected positive and negative effects on covered species associated with the proposed duration. The HCP terms generally compliment the term of a project operating license, but more importantly reflect a desire to provide long-term protection assurances for the Plan species that also account for oceanic condition changes that may occur over a longer period of time.

The HCP handbook addendum recommends a 90-day public comment period for large scale, regional or complex HCPs. The addendum notes that 60 days would be appropriate if the applicant has taken steps to involve the public early in the process. In this process, the public was provided with four months to comment on the draft EIS; interested parties participated directly in developing the revised HCPs over the course of 6 months; and an additional comment period of 30 days was provided on the revised HCP permit applications.

2.4 ACTIONS COMMON TO ALL ALTERNATIVES

Only those project operations that affect fish passage would be altered, if necessary, to assist in increasing the overall salmon and steelhead survival rates. Studies to evaluate and improve fish passage have been ongoing since the dams were constructed. As a result, the key factors influencing fish passage have already been identified. Project operations that are included under all of the alternatives are:

- fishways,
- fishladders,
- fish bypass,
- turbine operations,
- predator control,
- hatcheries, and
- spill.

The four tributaries where funds for the Plan Species Account would be directed under the HCP (Wenatchee, Entiat, Methow, and Okanogan) have threatened (bull trout) and endangered (spring-run chinook and steelhead) species. Numerous efforts are being, or will be, implemented to improve fish survival and breeding opportunities in the streams that are unrelated to the operation of the Wells, Rocky Reach, and Rock Island dams or the HCPs. These separate improvement activities (not funded by the PUDs) would continue under all alternatives.

2.5 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

During the scoping process of this EIS, several other *independent* alternatives were considered but eliminated from further analysis for two main reasons: either (1) the alternative in itself did not allow for the continued operation of the hydroelectric projects, or (2) the alternative did not satisfactorily address the entire range of issues affecting Endangered Species Act-listed species. These independent alternatives are described in more detail in the following sections.

Note that all alternatives in this EIS contain several specific measures that may be implemented at each project. By themselves, these measures are unlikely to result in recovery of Endangered Species Act-listed salmonid species or to significantly enhance the number of unlisted anadromous salmonids returning to the basin. Each measure typically affects just one component of a multi-faceted problem and either impacts other areas of the salmonid life cycle or inadequately provides the protection necessary to recover the species to harvestable levels without

the concurrent implementation of additional measures. Where appropriate, however, specific components of these measures are included in the two action alternatives. Included below is a discussion of why individual protection measures were not considered as unique alternatives.

2.5.1 DAM REMOVAL

Dam removal would return the Mid-Columbia River to a free-flowing state that would arguably provide the greatest benefits to salmon and steelhead. The dam passage impacts would be eliminated and additional spawning and rearing habitat for some Plan species would be created. Dam removal is extremely controversial, and can only be legally mandated at project relicensing. Over the next 10 years, the removal of Wells and Rocky Reach dams may be considered and addressed under the relicensing efforts for the projects if requested by interested parties. Dam removal for the Rock Island Project would not be

evaluated until 2028, when its license is up for renewal.

Under the shortest possible time frame, it is likely that the decision to remove a dam would require up to 10 years, with an additional number of years needed to develop the procedures and to execute the deconstruction efforts. As an example, in 1995, the U.S. Army Corps of Engineers initiated a Lower Snake River Juvenile Salmon Migration Feasibility Study, which contemplated the removal of the four Lower Snake River dams. This effort was finally completed in 2002 with the issuance of a Record of Decision.

A similar process can be expected for removal of the Mid-Columbia River dams, if initiated during project relicensing. Throughout these studies and discussions, salmon and steelhead would continue to decline, possibly to extinction. Therefore, due to the legal constraints associated with mandating dam removal, the time involved, and the interim impacts to both juvenile and adult anadromous salmonids, dam removal is not considered a reasonable alternative and was not considered in detail. This alternative also does not meet the purpose and need of the project, which is to protect and enhance anadromous fish populations and allow the PUDS to continue to generate electricity.

2.5.2 JUVENILE FISH BYPASS SYSTEMS

Although juvenile fish bypass systems have been included as a part of all alternatives evaluated in detail, they would not provide sufficient protection for the recovery of the species as an independent alternative. Therefore, this alternative was not evaluated in detail. A juvenile fish bypass system provides a passage route around a dam's turbine units. It consists of a collection area that allows fish to enter the system from the project's forebay, a bypass conduit that transports fish around the dam, and an outfall located downstream of the project. Although existing spillway structures and ice and trash sluiceways (conduits designed to pass debris over

a dam) can be relatively effective at passing fish, the term juvenile bypass system usually refers to a facility specifically designed and suited to this task.

Bypass systems using standard length turbine intake guidance screens, currently in operation on the Lower Columbia and Snake rivers, typically pass approximately 70 percent of yearling salmonid outmigrants (stream-type chinook, steelhead and sockeye). These systems are less effective for subyearling outmigrants (ocean-type chinook) (approximately 50 percent), and they pose a significant risk of injury to sockeye and juvenile lamprey. Although extended length screens have improved the guidance of these systems to a degree, stress and injury continues to occur, and comparatively extensive operations and maintenance efforts can reduce their overall effectiveness.

Surface-oriented bypass systems typically provide juvenile fish passage without incorporating guidance screens. Entrances to these systems are designed to intercept juvenile salmon and steelhead in the upper part of the water column, before the fish enters the turbine unit intakes. Although preferable to screened bypass systems, only the Wells Dam surface bypass system has been consistently efficient at attracting and passing substantial numbers of juvenile anadromous salmonids. A permanent surface bypass system is being installed at the Rocky Reach dams, but it may be necessary to provide some additional protection and enhancement measures to meet the established survival levels for some species. Therefore, although juvenile bypass system development, construction, and operation are included in each of the alternatives, it is not expected to be an adequate alternative in and of itself for all species.

2.5.3 **SPILL**

In most cases, spill is an effective means of bypassing salmon and steelhead around a dam. However, spill alone would likely not provide sufficient protection for listed species without considerable impacts to other natural resources. In studies conducted on the Lower Columbia and Snake Rivers, spill has consistently resulted in higher survival levels for juvenile anadromous salmonids than for any other bypass methodology tested. However, the quantity of spill required to bypass significant numbers of juvenile fish may result in increased total dissolved gas levels and affect other water quality parameters.

When water is discharged over a spillway, air is drawn into the tailwater as flow plunges deep below the water surface. As this air reaches the higher pressures associated with increasing water depths, the air is forced into the water column. Increasing levels of spill draw increasing volumes of air to depth, forcing higher levels of the atmospheric gasses into the water. High concentrations (in excess of 120 percent of saturation) of some of these gasses (e.g., nitrogen) can be deadly to fish and other aquatic organisms. Therefore, the amount of water that can be discharged over a given spillway is limited by the amount of atmospheric gasses that are introduced into the tailwater.

At lower spill levels, the volume of water discharged typically passes proportionately higher numbers of fish. For example, if 20 percent of the total river flow is spilled, up to 40 percent of the juvenile anadromous salmonids may bypass the dam via the spillway. As the spill volume increases, to 60 percent for example, only 60 percent of the juvenile anadromous salmonids might pass the spillway. In many cases, 60 percent spill would produce total dissolved gas levels above the Washington Department of Ecology limit of 120 percent in the tailrace and 115 percent at the next downstream dam. At the Mid-Columbia River projects, the maximum spill level is expected to be closer to 40 percent.

Spill is currently the primary measure to pass juvenile fish at Rock Island Dam, and is the primary measure proposed under Alternatives 2 and 3 for Rock Island. It is also a component of the Wells Dam bypass system. However, it is not as effective at Rocky Reach Dam. Spill is a component of the alternatives considered in detail, and will likely assist in meeting the overall survival requirements. In and of itself, however, spill is not expected to satisfy all of the needs of listed species, and was therefore eliminated as an independent alternative for detailed consideration.

2.5.4 FISH TRANSPORTATION

An alternative method of fish passage is to collect juvenile salmon and steelhead at dams as they migrate downstream and then transport the fish by truck or barge around the downstream dams and reservoirs. Advantages of fish transportation include protection from direct and cumulative turbine passage mortality, from predation in the reservoirs and tailraces, and from gas supersaturation caused by excessive levels of spill. Transportation can also help to minimize delays in migration that are caused by slack water in the reservoirs between dams.

Transportation additionally requires the construction of juvenile collection systems that include dewatering structures and separator facilities to enable barge and truck loading facilities. The transportation program is also limited by the ability of the mechanical bypass collection systems to effectively attract juvenile anadromous salmonids. Under certain conditions. transportation may also result in lower adult returns and may increase the level of straying. Currently, fish are transported in the Lower Snake and Columbia Rivers where bypass and separator facilities have been constructed, although fish transportation has not occurred at the three Mid-Columbia River dams (Wells, Rocky Reach, and Rock Island). Although transportation assessments were conducted for the Wells and Priest Rapids hydroelectric projects, the results were generally inconclusive regarding the benefits of transportation on adult return rates, compared to in-river migration.

Given the requirement to design, construct, and install juvenile collection, separator, and loading facilities, transportation is not a valid option in and of itself. In addition, due to the potential stress, injury, and mortality to juvenile anadromous salmonids associated with these systems, and the expectation that guidance efficiencies will fall short of supporting the required survival levels, this alternative has been eliminated from consideration as a stand alone-option. Also as a result of these factors, and the uncertainties related to the overall benefits of transportation, this measure is not included as a component of the two action alternatives addressed in this EIS.

2.5.5 ARTIFICIAL FISH PRODUCTION

The assumption governing this alternative is that juvenile and adult anadromous salmonids that are killed incidentally to project operations can be replaced by juvenile fish produced in a hatchery. Increases in production would likely occur at most of the existing hatcheries, and the number of juvenile fish produced would be based on the calculated fish passage mortality rate attributed to each dam. The goal of this effort would be to mitigate up to 100 percent of the dam-related passage mortality.

Based on several decades of hatchery mitigation and enhancement activities, it is now clear that this methodology alone will not recover Endangered Species Act-listed species or satisfactorily enhance naturally producing unlisted salmonid populations in the Columbia River Basin.

Hatchery fish can have direct and indirect effects on wild fish populations. Competition between the larger hatchery-reared juvenile salmon and steelhead and the smaller wild juvenile salmon and steelhead for food and space and the predation that is likely to occur between these populations may impact the wild fish. In addition, outplanting non-indigenous hatchery-reared juveniles into local habitats further reduces

the integrity of the wild populations by increasing the likelihood of genetic mixing. This results in a dilution of the wild gene pool, which affects the long-term health and viability of the wild populations.

As more and more hatchery fish are produced, wild stocks continue to be diluted in comparison to hatchery stocks, ultimately resulting in fewer and fewer wild fish. This continued decrease in the population of wild fish does not meet the objective of recovering an endangered or threatened species. Although limited artificial supplementation efforts utilizing locally adapted stocks would likely be a component of each action alternative to help prevent the extinction of listed species, and to compensate for a certain level of mortality for unlisted species, additional measures are required to ensure the species' longterm protection and enhancement. Therefore, based on the disadvantages associated with excessive supplementation levels, this alternative was eliminated from detailed consideration.

2.5.6 SEASONAL RESERVOIR DRAWDOWN

Seasonal reservoir drawdown refers to lowering the water level of the reservoir located immediately upstream of a dam during juvenile fish migration periods. This concept was initially developed on the Lower Snake River to reduce the time it takes water (and incidentally, juvenile salmon and steelhead) to travel through the reservoirs. Studies on the Columbia River Basin generally show a correlation between increased flow (water velocity) and increased fish migration rates. From these results, it has been generally inferred that this would result in higher juvenile salmon and steelhead survival. Although there is limited data on actual survival improvements, modeling data suggest that high flow conditions could provide greater survival (BPA et al. 1994a; NMFS 1998). While Giorgi et al. (2002) found little evidence of a flow-survival relationship, steelhead survival during the extreme low-flow conditions in 2001 were dramatically reduced.

Rapidly increasing temperatures and higher rates of residualism among juvenile steelhead were also implicated as a causative factor in this reduced survival.

To decrease water particle travel time, either additional flow must be provided through the reservoir or the cross-sectional area of the reservoir must be reduced. Drawdown reduces the cross-sectional area of project reservoirs.

As the concept of reservoir drawdown was more thoroughly developed on the Lower Snake River, lowering the reservoir to slightly above the spillway crest was evaluated. This level of drawdown was intended to create sections of freeflowing river in the tailrace areas of the next upstream dam, and thus return the river to a more natural state. The Army Corps of Engineers evaluated the effects of seasonal reservoir drawdown that would only be in effect during the juvenile migrating of anadromous salmonids. They found that significant modifications would be necessary to the existing fish passage facilities, and the seasonally fluctuating reservoirs would impact existing wildlife habitat, riparian habitat and salmon and steelhead spawning and rearing habitats. Significant loss of power production would also occur, as would impacts to irrigation, municipalities, and industry.

On the Mid-Columbia River, higher flows have been correlated to improved migration speed for sockeye salmon and steelhead. However, no significant correlation was identified for the other salmonid species, and there was no consistent relationship between flows and survival for most species (NMFS 2000a). Therefore, in and of itself, improving water particle travel time will not significantly improve conditions for all Endangered Species Act-listed or unlisted

species. In addition, seasonal spillway crest drawdowns have a considerable number of associated habitat impacts and a significant loss of power production that render this option impractical. It is therefore not considered a realistic alternative and has not been evaluated in this analysis.

2.5.7 CONTINUOUS SPILL PROGRAM

Although spill is included in all action alternatives, it was not considered on a continuous basis to cover 100 percent of the juvenile migration period. A continuous spill program may render the projects uneconomical with minimal increases in juvenile survival. This option was therefore not considered a practicable alternative. However, Alternative 2 includes the option of increasing spill to cover up to 99 percent of the migration periods.

2.5.8 Non-Power Operations

Section 15(b) of the Federal Power Act authorizes FERC to issue a license for non-power use when it "finds that, in conformity with a comprehensive plan for improving or developing a waterway or waterways for beneficial public uses, all or part of any licensed project should no longer be used or adapted for use for power purposes." If nonpower licenses were granted to any of the Mid-Columbia River dams, power production would presumably cease (except for potential emergency power requirements of the project) and all the flow would pass through the spillways and fishways. No entity has recommended issuance of a non-power license, and this would only occur at the time of relicensing. Note that dam decommissioning and possibly seasonal reservoir drawdown would result in non-power operations.

2.6 ALTERNATIVE COMPARISON

Because all three of the alternatives strive to improve fish survival at the dams, this section describes both the environmental differences among the alternatives at the project site and the procedural differences for implementing the alternatives, as shown in Table 2-8 and described below.

The most significant differences among the alternatives are the scope of the species covered, the statutory obligations satisfied, the parties that support the alternatives, and the timing and certainty for implementation. For example, under Alternative 1, current FERC license requirements would address all species but may or may not address the additional requirements of the Endangered Species Act. Alternative 2 would result in an additional protection plan for anadromous salmonid species but is primarily concerned with the protection and recovery of Endangered Species Act-listed Upper Columbia River steelhead and spring-run chinook salmon. A new Endangered Species Act consultation would occur at the time each project is relicensed, or when significant new information is available that indicates that existing protection measures are not adequate for the listed fish and a reopener clause proceeding is initiated. This would help in the protection of anadromous salmonids. Finally, Alternative 3 (Proposed Action) represents longterm settlements of the anadromous salmonid issues for each project under the current licenses and at relicensing for all anadromous salmonid species in the project area. Alternative 3 would be effective for a 50-year term, although comprehensive reviews of the programs and species status would occur every 10 years.

2.6.1 AFFECTED SPECIES

2.6.1.1 Alternative 1 (No-Action)

For purposes of comparison only, it is assumed that protection for the listed and non-listed anadromous salmonid species would be limited to existing measures under current FERC licenses and agreements. Existing measures, however, may not prevent the extinction of listed species, nor are they expected to increase the populations of non-listed species above current levels.

2.6.1.2 Alternative 2

Alternative 2 includes the protective measures identified in Alternative 1, as well as additional measures to protect listed anadromous species. Authorities afforded to NMFS under the Endangered Species Act would apply to Upper Columbia River steelhead, Upper Columbia River spring-run chinook salmon, and Mid-Columbia River steelhead. Protection for other Endangered Species Act-listed species (including bull trout) that might be impacted by the Mid-Columbia River hydroelectric projects would be addressed through separate but similar actions to those identified for Alternative 2.

NMFS and FERC also have obligations to protect anadromous species through the Federal Power Act through the relicensing or license reopener procedures. As with the other alternatives, additional protection for non-listed anadromous species is expected through these proceedings. However, the protection measures are not expected to be as comprehensive as those that apply to the listed species.

2.6.1.3 Alternative 3

The HCPs provide the same level of protection for sockeye, summer/fall-run chinook, and coho salmon as they provide to the Endangered Species Act-listed species. Although the wild population of coho salmon has been extirpated from the action area, the HCPs provide measures to protect reintroduced populations. Although the impacts to Mid-Columbia River steelhead² are likely limited to water quality issues, this species is not specifically addressed in the HCP agreements. Protection for bull trout or other Endangered Species Act-listed species would be addressed under separate Section 7 consultations.

² This Evolutionarily Significant Unit includes all naturally spawned populations of steelhead in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington; but excluding steelhead from the Snake River.

COMPARISON OF ALTERNATIVES FOR ANADROMOUS SALMONID CONSERVATION MEASURES **TABLE 2-8.**

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ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Endangered Species Act Compliance	Endangered Species Act Continue with existing measures under Compliance current license conditions ¹	Section 7(a)(2) for ESA-listed species for all three projects	Section 10(a)(1) for all Plan species (applies to those species which are currently listed as well as those that could be listed in the future)
Duration of Each Alternative	50 years²	Same as Alternative 1 ²	50 years subject to withdrawal and termination provisions
Species Covered	All anadromous salmonid species	Same as Alternative 1, but additional measures would focus primarily on ESA listed species.	Same as Alternative 1
Protection Measures	Limited spill and bypass measures, continued operation of adult fishways	Additional project operational and structural modifications for listed species and potentially additional protection measures for non-listed anadromous fish through the issuance of a new license; determination and implementation of measures would depend on ESA consultations, negotiations, and Federal Power Act authorities.	Following HCP approval, immediate implementation of additional project operational and structural modifications for all Plan species, as well as habitat improvement measures
Implementation Timing	Protection measures currently being implemented	Protection measures to be implemented during relicensing, license amendments or under reopener clause proceedings, but subject to Section 7(a)(2) consultations; implementation would occur following FERC approval of the measures, which typically occurs up to 5 years following commencement of formal ESA consultation	Implemented immediately following HCP approval
Performance Standards	Currently based on fish passage efficiency for specific measures, such as a specified spill level for a fixed period of time or until moneys in the Fish Conservation Account are exhausted (no project or species level standards)	Same as Alternative 1, except for the likely development of appropriate survival standards for listed species through ESA consultations, as well as some potential for developing survival standards for non-listed anadromous salmonid species through the Federal Power Act	No net impact for all Plan species - 91% combined adult and juvenile project (reservoir and dam) passage survival, or 93% juvenile project passage survival, or 95% juvenile dam (forebay, dam, and tailrace) passage survival; compensation to obtain no net impact also includes up to 7% hatchery programs and 2% to tributary programs

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– Proje	Астом	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
ct Description	Project Lead for Identifying and Implementing Protection Measures	FERC through the existing coordinating committees	Same as Alternative 1 or through new license conditions	HCP coordinating committees
	Location of Fish Protection Measures	Project area, including reservoir, dam structures, tailrace, and hatcheries	Same as Alternative 1	Same as Altemative 1 and additionally including Wenatchee, Entiat, Methow, and Okanogan Rivers and tributaries
	No Surprises Policy	Not applicable	Not applicable	Applicable, subject to certain circumstances defined in the withdrawal provisions of the HCP agreements
2-76	Continued Studies to Assess Survival	Needed to verify fish passage measures at Rock Island and Rocky Reach dams	Same as Alternative 1	At least 3 years of evaluation for each Plan species, and periodic reevaluations every 10 years or as determined by the HCP Coordinating Committees
	Monitoring Following Statement/Permit Issuance	Not applicable	As needed to ensure effectiveness of measures and status of salmonid species	Periodic monitoring to verify survival for all Plan species
FEIS f	Future Provisions for Other Aquatic Species	Would occur under relicensing or under existing license reopener clauses	Same as Alternative 1, although Endangered Species Act-listed species would be covered under separate consultations	Same as Altemative 2
or the Wells, Rocky Reac	Hatchery Compensation	Continued hatchery funding at present level, for inundation compensation levels and ongoing unavoidable losses (hatchery compensation can be adjusted for Wells based on actual losses)	Same as Alternative 1, although production levels may be reduced at any time based on potential effects to listed species	Continued hatchery funding for inundation compensation levels; hatchery funding would be established to mitigate for unavoidable losses; initially, mitigation would be set to achieve a 7 percent compensation level but could be adjusted periodically based upon the results of survival studies; additional survival reevaluations would take place every 10 years

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	Астом	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
s, Rocky Reach, and	Tributary Improvements	No PUD-funded improvements	Same as Alternative 1	PUD contributions to the Plan Species Account would pay for projects that improve salmon and steelhead habitat in the Wenatchee, Entiat, Methow, and Okanogan River Basins, as well as the Mid-Columbia River mainstem; the combined funding over the 50-year term of the HCPs is over \$46.5 million, and is specified and guaranteed in the HCPs
	On-Site Protection Measures	rres		
2-77	Wells	Adult Passage: Continue operation and maintenance of adult fishways, evaluate and improve fishway operations, if adult fish passage problems are identified, develop solutions to the problems	Adult Passage: Same as Alternative 1 or as needed to prevent the extinction of listed species; conduct spawning success evaluations, operate surface bypass system during adult steelhead and spring-run chinook migration periods and downstream kelt passage period	Adult Passage: Same as Alternative 1, with the additional requirement to meet the 91% combined adult and juvenile survival standards for all Plan species
		Juvenile Passage: Evaluate and control total dissolved gas, continue, operate surface bypass system to achieve 80% fish passage efficiency for spring and summer migrants	Juvenile Passage: In addition to measures in Alternative 1: operate the turbines as efficiently as possible, operate surface bypass system 24 hours/day for up 0.9% of juvenile migration, increase spill as needed to improve survival but limited by dissolved nas	Juvenile Passage: Meet 93% project passage survival or 95% dam passage survival for all Plan species by increasing effectiveness of juvenile bypass system, spill gates, predator control, and turbine usage, or through other measures
Chi				
apter 2 – Project Descrip	Rocky Reach	Adult Passage: Continue to operate and maintain adult fishladders, operate powerhouse units within 1% of peak efficiency	Adult Passage: Continue operation and maintenance of adult fishways, evaluate and improve fishway operations, conduct modeling and develop solutions for adult fish passage problems, use spillway flow configurations to optimize adult fishway attraction flows, provide safe passage for adult fallbacks and kelts, evaluate biological impacts of adult passage	Adult Passage: Same as for Wells (above)

COMPARISON OF ALTERNATIVES FOR ANADROMOUS SALMONID CONSERVATION MEASURES (CONTINUED)

	Action	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
ct Description		Juvenile Passage: Operate the turbines as efficiently as possible during the migration seasons, spill 15% of daily river flow for 42 days of the spring migration period and 10% for 34 days during the summer migration; evaluate and construct a permanent bypass system and replace old turbine runners, control total dissolved gas, continue predator control measures, monitor passage and total dissolved gas levels to meet requirements	Juvenile Passage: Same as Alternative 1, except for additional spill to improve juvenile fish passage survival rates to cover up to 99% of the migration period, but limited by dissolved gas levels; consider additional or alternative juvenile bypass options such as a sluiceway	Juvenile Passage: Construct and operate a new juvenile bypass facility and spill 15% of the daily average river flow, over 95% of the migration period of each Plan species (in addition, spill is increased to 25% for three weeks during the spring migration period to further protect sockeye), or as necessary to meet the survival standards listed above for Wells Dam, other operational criteria would be similar to Alternative 1
	Rock Island	Adult Passage: Continue to operate and maintain adult fishladders	Adult Passage: Same as for Rocky Reach (above)	Adult Passage: Same as for Wells (above)
2-78		Juvenile Passage: Provide spill as requested by Fishery Agencies and Tribes through the Fish Conservation Account (currently assessed at about \$3.2 million), evaluate fish guidance efficiency, control gas abatement, continue predator control measures	Juvenile Passage: Increase spill to improve juvenile fish passage survival rates to cover up to 99% of the migration period, but limited by dissolved gas levels; enhance spillway passage efficiency, preferentially use Powerhouse 2 turbines, and minimize use of Nagler turbines	Juvenile Passage: Spill 20% of the daily average river flow, over 95% of the migration period of each Plan species; also strive to meet the survival standards listed above for Wells
	Dispute Resolution	Disputes resolved by Wells, Rock Island, and Mid-Columbia Coordinating Committees or FERC and/or in court	Disputes are resolved by NMFS, FERC, and/or in court	Disputes resolved by coordinating committees or policy committees, if no resolution is reached, procedures would be similar to Alternative 2
d≥ for the Wells	Additional Protection Measures	As negotiated during relicensing or license re-opener clauses	Other measures as required by FERC and NMFS to ensure protection of salmonid species and recovery of the listed species	As determined by the HCP coordinating committee to meet the survival standards for all Plan species

Alternative 1 (no-action alternative) represents existing baseline conditions for comparative purposes only. The measures implemented under Alternative 1 may not comply with the Endangered Species Act.

TABLE 2-8.

² Considered for comparison purposes only.

2.6.2 PROCEDURAL DIFFERENCES

2.6.2.1 Alternative 1 (No-Action)

Provisions of this alternative would be implemented under existing FERC license conditions, which currently include use of several coordinating committees. The committees consist of members representing fishery agencies, Tribes, and PUDs. The protection measures implemented through this process require unanimous consent of all parties. This has resulted in contested proceedings and legal debates among the parties that have significantly delayed implementation of fish protection measures. This alternative does not contemplate additional protection for listed or unlisted anadromous fish, and may not satisfy Endangered Species Act requirements.

2.6.2.2 Alternative 2

In addition to measures implemented through existing FERC license conditions, NMFS has the legal authority under the Endangered Species Act to recommend additional measures necessary to ensure that any FERC action affecting the projects does not jeopardize the continued existence of listed species. Such actions include relicensing proceedings, license amendments and proceedings under the reopener clauses. NMFS may also identify the most appropriate measures to be taken at each project and modify the measures as needed if species continue to decline. FERC, as the action agency, must include these measures in the license to obtain exemption from the take prohibitions as described under Section 9 of the Endangered Species Act. Under Section 7, NMFS has a legal responsibility to provide the benefit of the doubt to listed species with respect to gaps in the information base.

If FERC or the PUDs disagree with NMFS's decisions under this process, lengthy legal proceedings may ensue. During these proceedings, measures in addition to those

already included in the FERC-issued operating licenses and settlement agreements are not likely to be implemented.

Species not listed under the Endangered Species Act would be addressed through NMFS's authorities under the Federal Power Act and the Magnuson-Stevens Fishery Conservation and Management Act, although these species might also benefit from actions implemented for the listed species. In addition, FERC relicensing or license reopener proceedings are expected to result in greater protection measures for all anadromous species.

2.6.2.3 Alternative 3

According to HCP provisions, the primary authority to determine the appropriate protection measures for each Plan species is provided to the coordinating committees (comprised of the PUD responsible for the HCP, NMFS, and each of the signatories to the agreement) for a joint decision on the appropriate measures. In the case of a dispute, if the coordinating committee cannot reach a unanimous agreement within 20 days, the dispute would be referred to the policy committee. If the policy committee cannot reach a unanimous agreement within 30 days, the HCP parties may pursue any other right that they might otherwise have to affect a decision, which would be similar to the dispute resolution options available under Alternatives 1 and 2.

Because the HCPs establish specific actions, responsibilities, and duties to be carried out by the PUDs, each of the signatories to the agreements agrees not to institute any action under the Endangered Species Act, the Federal Power Act, the Fish and Wildlife Coordination Act, the Pacific Northwest Electric Power Planning Conservation Act, Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act, or Title 77 RCW with regard to the Plan species for these three projects (except as noted for the dispute resolution process). NMFS's No Surprises policy

(which ensures the PUDs that NMFS would not request additional measures during the term of this agreement) would be in effect. However, the No Surprises policy would not affect the ability of NMFS to withdraw from the HCP agreements under the withdrawal provisions. While the No Surprises policy ensures that the HCP goals remain the same, the measures needed to achieve the goals could change.

2.6.3 TIME FRAME

2.6.3.1 Alternative 1 (No-Action)

Fish protection measures included in this alternative would occur throughout the term of the FERC-issued operating licenses. Project operations would continue as occurs presently regardless of future listings or delisting. FERC license periods are typically 30 to 50 years, and the Wells, Rocky Reach, and Rock Island projects would be relicensed over the next 26 years. It is recognized that additional fish protection measures could be implemented during relicensing and potentially through reopener clause negotiations, as described above. However, the pursuit of additional protective measures through these venues is evaluated in Alternative 2. Thus, for comparative purposes, it is assumed that the time frame evaluated for Alternative 1 is the same as the 50-year HCP term, and that no additional measures are adopted during that time period.

2.6.3.2 Alternative 2

The time frame is the same as Alternative 1.

2.6.3.3 Alternative 3

The HCPs would be in effect for a 50-year period beginning in approximately 2003, the date that the agreements are expected to be adopted by FERC as amendments to the FERC licenses (currently expected to be June 2003 through May 2053), except for defined termination procedures.

2.6.4 GOALS AND OBJECTIVES

2.6.4.1 Alternative 1 (No-Action)

This alternative may not provide specific provisions to ensure the continued existence or recovery of Endangered Species Act-listed fish species. Protection measures would continue to be implemented in accordance with existing FERC license articles and settlement agreements. Goals and objectives tend to be specific for each measure at each dam (i.e., no outcome-based performance standards).

2.6.4.2 Alternative 2

This alternative includes regulatory options under the Federal Power Act and Endangered Species Act. No specific project goals are identified, although the general consensus is to maximize salmonid survivability through the projects. Although outcome-based performance (survival) standards are likely to be established for the listed species, it is uncertain whether similar standards would be set for non-listed species.

2.6.4.3 Alternative 3

The HCPs provide long-term agreements to protect the Endangered Species-listed and non-listed salmon and steelhead, with the goal of having no net impact to all the Plan species. The no net impact standard would be achieved through project-specific protection measures, hatchery production, and tributary habitat enhancement projects.

2.6.5 IMPLEMENTATION SCHEDULE

The three alternatives have different schedules for the implementation of the conservation measures, based on the mechanism used to establish the measures. The conservation measures included under Alternative 1 represent existing conditions and are therefore currently being implemented for all species, although the operational criteria for Rocky Reach Dam (provided by the Fourth Revised Interim Stipulation) have expired. As a result, additional negotiations would be required to develop new operational criteria for Rocky Reach Dam. However, the biological opinion issued by NMFS for the construction and operation of the permanent bypass system would be the likely starting point.

Additional measures implemented under Alternative 2 during the established 50-year timeline would be accomplished through the procedures available in the Federal Power Act, including relicensing or license reopener procedures. It is unknown when additional conservation measures would be implemented under Alternative 2, except during the established relicensing dates. However, previous negotiations have typically taken a number of years to reach agreement. There is also the potential for requiring legal proceedings to establish the conservation measures.

Additional Endangered Species Act consultations would be needed to establish conservation measures for the listed species. It is uncertain how long it would take to complete the consultation proceedings and the subsequent license amendment processes.

A number of the provisions provided under Alternative 3 have already been voluntarily implemented by the PUDs based on the staggered effective dates of Chelan County PUD's HCPs and Douglas County PUD's expectation that the HCPs will be approved and permitted by the appropriate regulatory agencies. The remaining provisions would be implemented when the HCPs are amended to the FERC licenses. As a result, no additional negotiations or consultations would be required to begin implementation of the conservation measures. In addition, legal challenges between the PUDs and the agencies would be substantially minimized or eliminated.

2.6.6 ADDITIONAL MEASURES

2.6.6.1 Alternative 1 (No-Action)

This alternative does not provide a procedure to require implementation of mitigation measures beyond the project's boundaries (i.e., tributary habitat improvements). Under Alternative 1, hatchery supplementation is addressed through the existing settlement agreements and license articles.

2.6.6.2 Alternative 2

Under Alternative 2, additional protection would likely be provided to the Endangered Species Act-listed fish by NMFS. If NMFS determines that the current hatchery production levels would compromise the genetic integrity of Endangered Species Act-listed fish, the production levels would be reduced. Such a determination could occur at anytime, because it would be considered significant new information warranting reinitiation of consultation. Other measures could also be implemented at any time through consultations based on new information.

Provisions of the Clean Water Act, Federal Power Act, Northwest Power Planning Act, Tribal treaties, and other laws and statutes are available under Alternative 2 to protect and restore Upper Columbia anadromous fish through increased operational and structural measures and supplementation.

2.6.6.3 Alternative 3

The HCPs include a funding process for the protection and restoration of Plan species' habitat within the Columbia River watershed (from the Chief Joseph project tailrace to the Rock Island Project tailrace) and in the Okanogan, Methow, Entiat, and Wenatchee River watersheds. In addition, hatchery compensation plans guarantee funding and capacity to meet the 7 percent compensation level necessary to achieve no net

impact. Hatchery compensation levels, with few exceptions, would not change until 2013, and every 10 years thereafter.

Similar to Alternative 2, provisions of other laws, statutes, and Tribal treaties are available under Alternative 3 to protect and restore Mid-Columbia anadromous fish through increased operational and structural measures and supplementation. However, specific provisions in these laws and statutes that are under the

jurisdiction of NMFS (and other signatory parties) would be subject to the terms and conditions of the HCPs.

2.6.7 OTHER ENVIRONMENTAL DIFFERENCES

Table 2-9 provides a summary comparison of how the alternatives affect other environmental resources in the project area. This information is further described in Chapter 4.

2.7 Preferred Alternative

The proposed action (Alternative 3) is the preferred alternative of the project proponents (Douglas County and Chelan County PUDs) and NMFS, as well as USFWS, WDFW, and the Colville Tribe. NMFS will describe its preferred alternative and the rationale for selecting it in a ROD issued following review of this FEIS. The review by NMFS is guided by both the Endangered Species Act and NEPA requirements. The major NEPA-related issues that NMFS considered in making its decision were:

- Was the environmental review process adequate?
- Were the impacts adequately discussed and significant adverse impacts mitigated?
- Were all reasonable and appropriate alternatives to the proposed action considered?
- Are there significant unavoidable adverse impacts associated with the preferred alternative?
- What were the values that were considered, and what is the basis for the decision?
- Are there any outstanding unresolved issues?
- Will the preferred alternative result in the irrevocable commitment of Federal resources?

- Does the preferred alternative meet the applicants' purpose and need?
- What are the major differences between the preferred alternative and the proposed action?

In addition to analyzing all human and biological resources potentially affected by the preferred alternative, the major Endangered Species Act issues that NMFS considered were related to the overall protection and recovery of the salmon and steelhead species covered by the incidental take permit. To document its analysis and decision making, NMFS would issue a biological opinion to assist in deciding whether the HCPs satisfy the requirements of Section 10(2)(B) of the Endangered Species Act. The biological opinion analysis by NMFS will involve:

- determining the biological requirements within the proposed action area,
- determining the status of the species within the action area,
- determining the factors affecting the species environment within the action area,
- determining the effects of the proposed action on species-level biological requirements, and
- evaluating the cumulative effects associated with the proposed action.

Prior to amending the project licenses, FERC is expected to consult with USFWS to evaluate any

impacts on listed species not included as Permit species (e.g., bull trout). The FERC is also expected to initiate consultation with NMFS at this time to evaluate any impacts on listed anadromous species. However, it is assumed that absent any new information, FERC's proposed license amendments would be identical to the proposed actions already evaluated in the biological opinions on NMFS's issuance of the incidental take permits and the NMFS's findings would be identical.

The ROD for this EIS will certify the adequacy of the HCPs' environmental review process and will incorporate the requirements of the permit, including the mitigation commitments of the applicants.

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	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Land Features, Geology, and Soils	d Soils		
Project Area Soils	Same as existing conditions.	Same as Alternative 1. If reservoir drawdown occurs, portions of the river cross-sectional areas would decrease to the original size of the river. In the short-term, riparian and shoreline areas would be disturbed and eventually mainstem spawning, incubation, and rearing habitat would be increased.	Same as Alternative 2.
Reservoir Erosion and Sedimentation	Same as existing conditions.	Same as Alternative 1. If reservoir drawdown occurs, erosion and reservoir turbidity would initially increase over the short term and damage aquatic habitat conditions, with the greatest damage occurring during the first 4 to 7 years. Turbidity would decrease over time, and habitat conditions would improve. However, increased turbidity could also provide cover for juvenile fish from predators. Natural river sediment transport regimes would be restored, which could increase salmonid production through improved spawning and rearing habitat. Increased rates of sediment deposition would take place in the reservoir immediately downstream of the drawn down reservoir.	Same as Alternative 2.
Associated Tributaries	Geologic conditions conducive to fish habitat are expected to improve from independent local and State funded WRIA fish habitat enhancement projects.	Same as Alternative 1. If reservoir drawdown occurs, tributary channel mouths would erode each year. However, additional spawning habitat would likely be provided at the confluence with the mainstem.	Same as Alternative 2, with additional improvements to the geomorphic condition of the stream channel through the PUD-funded tributary habitat enhancement programs.
Columbia River System/Cumulative Effects	Same as existing conditions.	Same as Alternative 1. If reservoir drawdown occurs, increased sediment and turbidity over the short-term particularly in the reservoirs immediately downstream of the drawn down project.	Same as Alternative 2.

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Fisheries Resources Anadromous Salmonia Juvenile Migration/Survival Standards	Anadromous Salmoni Juvenile Migration/Survival Standards			
Anadromous Salmonids and Other Listed Species (bull trout) Juvenile Migration/Survival Standards Project-specific fish passage standards, no additional specific protection measures for threatened or endangered species. Project-specific fish passage standards, no additional specific protection measures for threatened or endangered species. Project-specific fish passage standards, no additional specific protection measures for threatened or endangered species. Project-specific fish passage standards, no additional specific protection measures for threatened or endangered species. Standards	ds and Other Listed Species (bull trout) Project-specific fish passage standards, no additional specific protection measures for threatened or endangered species. Protection for listed and non-listed species would be provided by laws and statutes other than the ESA.	Wells Dam: Provide a non-turbine passage route (juvenile bypass system) to pass at least 80% of spring-run outmigrants and 70% of summer outmigrants.	Rocky Reach Dam: Provide safe (less than 2 percent mortality) non-turbine passage route (juvenile bypass or spillway passage) for 80% of juvenile migrants over 90% of the migration period.	Rock Island Dam: Fund an account to purchase spill, as requested by fish agencies and the Tribes, to an annual revenue loss of
Same as Alternative 1. Additional measures may be required under FERC licensing or ESA requirements that are likely to include increased use of spill to improve juvenile fish passage survival. Bull trout protection would be provided through consultation with USFWS.	Same as Alternative 1. Additional measures may be required under FERC licensing or ESA requirements that are likely to include increased use of spill to improve juvenile fish passage survival. Bull trout protection would be provided through consultation with USFWS.	Wells Dam: Potentially increase the use of spill and extend the operational time frame of the juvenile bypass system to up to 40% of daily average flow through 99% of the juvenile migration periods.	Rocky Reach Dam: Same as Wells Dam above.	Rock Island Dam: Same as Wells Dam above.
No net impact standard - 91% combine and juvenile project passage survival, juvenile dam passage survival for all species. Compensation to obtain no nimpact also includes 7% to hatchery pland 2% to tributary programs. Bull trop protection would be similar to Alternati	No net impact standard - 91% combined adult and juvenile project passage survival, or 95% juvenile dam passage survival for all Plan species. Compensation to obtain no net impact also includes 7% to hatchery programs and 2% to tributary programs. Bull trout protection would be similar to Alternative 2.			

COMPARISON OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Adult Migration/ Survival Standards	Maintain and operate fishladders according to criteria established in the existing settlement agreements or by the fishery agencies. Project-specific standards, with no specific protection measures for threatened or endangered species. Protection for all species would be provided by laws and statutes other than the ESA.	As required to minimize the impacts to salmonid species. The PUDs would each consult with FERC and NMFS for anadromous salmonids, and with USFWS for bull trout.	No net impact standard - 91% combined adult and juvenile project passage survival, 93 % juvenile project survival, or 95% juvenile dam passage survival for all Plan species. Compensation to obtain no net impact also includes 7% to hatchery programs and 2% to tributary programs. Bull trout protection would be similar to Alternative 2.
Hatchery Production	Hatchery mitigation for initial loss of habitat from dam construction would continue over the long term. Hatchery funding for unavoidable losses from fish passage would follow existing settlement agreements.	Same as Alternative 1. Production could be reduced at any time if significant impacts to listed species are likely to occur. Production could be reduced based on actual fish passage losses. Production would be adjusted at relicensing.	Same as Alternative 1, except the initial production levels would be based on compensating for assumed unavoidable project passage mortality. Production levels would not change until at least 2013. Compensation for unavoidable losses at Wells Dam would be adjusted to 3.8% for yearling chinook and steelhead and 7% for sockeye and subyearling chinook from the currently assumed 14% rate for all species. Exact production levels based upon the actual numbers of returning adults. Hatchery production would not be less than that specified to address initial project inundation.
Independent (Non-PUD Funded) Tributaries Habitat Improvements	Habitat improvements could occur through the implementation of non-PUD funded projects through Federal, State, and local agency funding, specifically WRIA-funded projects.	Same as Altemative 1.	Same as Altemative 1.
PUD-Funded Habitat Improvements	None.	Same as Altemative 1.	\$46.5 million (1998 dollars) additional funding provided through the HCPs to compensate for the 2% unavoidable project mortality.

COMPARISON OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

TABLE 2-9.

	AL TERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Monitoring	At Wells, run timing, total dissolved gas, and system efficiency monitoring would continue. At Bocky Reach and Bock Island, only monitoring to ensure facility modifications are achieving criteria identified in license articles, settlements, and stipulations.	Same as Alternative 1, with additional survival studies for Endangered Species Actlisted juveniles and adults.	Studies necessary to verify that standards are being met for all Plan species will take place during Phase I, periodic monitoring to verify that standards continue to be met during Phase III, and periodic monitoring in Phase II to evaluate survival improvements.
Drawdown	Drawdown cannot be required under existing licenses.	Drawdown could increase survival rates of migrating juvenile fish over the long term. However, lower water levels could initially increase predator density and predator/prey encounters. Over the short term, drawdown would decrease water quality, fish habitat, and foraging opportunities, and likely affect survival rates. Only an option at relicensing. Also see Land Features, Geology, and Soils section.	Same as Alternative 2, although this is unlikely to occur under the HCPs. However, the Services have the option of withdrawing from the HCPs to pursue drawdown or dam removal options under certain provision of the HCPs.
Bull Trout	No specific measures are identified to protect bull trout.	Protection measures as required to recover the species under the ESA (Section 7 consultation).	Same as Altemative 2.

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TABLE 2-9.

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
QAR Analysis	Based on analysis of Upper Columbia River spring-run chinook salmon and steelhead, the return rates for spring-run chinook salmon have been trending down at loss rate of 5 to 10% per year. Although complicated by the natural spawning of hatchery fish, wild steelhead populations in the Wenatchee and Entiat Rivers are trending down at a similar rate as the chinook populations, while the Methow River population is trending downward at a faster rate	Although maximizing survival at each of the PUD dams will increase the return rates of spring-run chinook salmon and steelhead, populations will continue to decline without reductions in non-hydro system related impacts (including higher ocean survival), although at a slower rate than Alternative 1.	Achieving the project survival and habitat improvement standards identified in the proposed HCPs will increase Mid-Columbia River reach survival by approximately 22 to 35% for steelhead and 27 to 45% for springrun chinook salmon. Under these survival rates, populations will continue to decline without reductions in non-hydro system related impacts, although at a slower rate than Alternatives 1 or 2, if survival conditions continue as they were for brood years 1980 - 1994. Commitments to habitat productivity, in addition to dam passage survival increases, will increase survival rates by an additional 6 to 10% over Alternative 2. Under the long-term scenario, achieving the survival standards in the HCPs alone would reduce the risk of extinction to acceptable levels. (The effects of long-term supplementation have not been analyzed.)
Other Species of Concern o	Other Species of Concern or Importance (lamprey, sturgeons, cutthroat trout, game species, etc.)	out, game species, etc.)	
Project Area	No change expected over existing conditions.	Improvements to fish bypass systems or an increase in spill volumes might occur. These measures would likely reduce the turbine entrainment of some resident species. Specific sections of the bypass systems could disproportionately affect some species (e.g., impingement of lamprey on turbine intake screens. Increased spill and resultant elevated levels of TDG may have negative impacts on the reproductive success of sturgeon and may impact the long-term health or food base of aquatic species located within the action area.	Spill requirements could change dependent on efficiency of juvenile bypass systems and/or meeting survival standards. Meeting the survival standards for all the Plan species would likely provide a wider range of protection for other species.

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	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
		Drawdown would affect habitats of reservoir fish, and access to and from tributary streams for migratory species. Habitat for species adapted to free-flowing river conditions (e.g., cutthroat trout) would increase or improve, while habitat for species better suited for reservoirs (e.g., bass) would diminish.	Same as Alternative 2.
Associated Tributaries	No direct effect. Habitat improvements could occur through the implementation of non-PUD-funded projects through Federal, State, and local agency funding.	Same as Alternative 1.	Habitat improvements funded by the HCP Plan Species Account would likely benefit bull trout, cutthroat trout and have added benefits to the health and productively of all native fish species that occur in the tributary streams.
Columbia River System/Cumulative Effects	No changes expected over existing conditions.	Same as Alternative 1.	Same as Alternative 1.
Water Quantity			
Project Area	No change in flows.	Amount of spill could increase to improve juvenile fish passage survival, particularly for listed species. Drawdown would increase water velocity.	Amount of spill could change dependent on efficiency of juvenile bypass systems and/or meeting the survival standards. However, water quantities would not be substantially altered. Effects from drawdown would be the same as Alternative 2.
Associated Tributaries	No effect. Some non-PUD-funded projects may help to increase water quantity in the tributaries.	Same as Alternative 1.	Additional funding by the PUDs through the Plan Species Account would likely provide for more water conservation projects and more improvements in tributary flows.
Columbia River System/Cumulative Effects	No changes expected over existing conditions.	Same as Alternative 1.	Same as Alternative 1.

COMPARISON OF ENVIRONMENTAL CONSEQUENCES (CONTINUED) **TABLE 2-9.**

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Water Quality			
Project Area Total Dissolved Gas	No change expected over existing conditions	Some improvement expected as Ecology imposes TMDL for Clean Water Act compliance and other measures (e.g., spill deflectors) are implemented at relicensing. Spill and total dissolved gas levels could increase if needed to improve anadromous fish passage efficiency or survival rates.	Same as Alternative 1, although spill could increase as needed to meet survival standards, resulting in an increase in total dissolved gas levels. However, spill is limited by Clean Water Act requirements. HCP signors agree to work collectively to address water quality issues.
Associated Tributaries	There is potential for incremental water quality improvements (e.g., higher dissolved oxygen, lower turbidity and sedimentation) as total maximum daily load program and other ongoing watershed restoration efforts proceed, and benefits from improved riparian protections are seen (no change from existing conditions).	Same as Alternative 1.	Same as Alternative 1, although guaranteed PUD funding would provide for more restoration projects and improvements in tributary water quality.
Columbia River System/Cumulative Effects	No change from existing conditions.	Spill programs may increase total dissolved gases in project area and at downstream hydroelectric projects.	Similar to Alternative 1, although the PUDs would work collectively to minimize total dissolved gas levels.
Vegetation			
Project Area	No change from existing conditions.	Same as Alternative 1. If reservoir drawdown occurs, it could impact shoreline and aquatic vegetation. One threatened plant species (giant hellborine) could potentially be affected by a drawdown and may require additional ESA consultation.	Same as Alternative 2 but may also include off-site improvements in the production and carrying capacity of the mainstem Columbia River.

COMPARISON OF ENVIRONMENTAL CONSEQUENCES (CONTINUED) **TABLE 2-9.**

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Associated Tributaries	Some local and State fish habitat improvement projects could improve riparian vegetation – no change from existing conditions.	Same as Altemative 1.	Same as Alternative 1, and HCP funding for tributary improvements would potentially benefit vegetation by removing invasive nonnative plant species, adding or enhancing soils, and establishing buffer areas along tributary streams.
Columbia River System/Cumulative Effects	No change from existing conditions.	Same as Alternative 1.	Same as Alternative 1.
Wildlife			
Threatened, Endangered, ar	Threatened, Endangered, and Sensitive Wildlife Species		
Project Area	No change from existing conditions.	No effect anticipated. If drawdown occurs, bald eagle abundance may decline due to declines in waterfowl prey.	Same as Altemative 2.
Associated Tributaries	Possible short-term disturbance to bald eagles from tributary habitat improvement projects conducted by other agencies. Possible benefits to bald eagles if projects improve riparian habitat and waterfowl prey base.	Same as Alternative 1.	Same as Altemative 1. HCP funding for tributary improvements could enhance habitat.
	No effects on northern spotted owls, gray wolves, or grizzly bears.		
	No change from existing conditions.		
Columbia River System/Cumulative Effects	No effect.	Same as Alternative 1.	Same as Alternative 1.

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(CONTINUED)
MPARISON OF ENVIRONMENTAL CONSEQUENCES (
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2-9.

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Other Wildlife			
Project Area	Possible decline in avian predator abundance due to continued implementation of predator control programs. No effect to other wildlife. No change from existing conditions.	Same as Alternative 1. If drawdown occurs, declines in abundance of waterfowl, aquatic furbearers, amphibians, and other riparianassociated wildlife may result.	Same as Alternative 2. In addition, HCP funding for tributary improvements could enhance habitat for fish and wildlife.
Associated Tributaries	Possible short-term disturbance to wildlife from tributary habitat improvement projects conducted by other agencies. Possible benefits to waterfowl, aquatic furbearers, and other riparian associated wildlife, if projects improve riparian habitat.	Same as Alternative 1	Same effects from PUD and other agency habitat improvement projects as Alternatives 1 and 2.
Columbia River System/Cumulative Effects	No effect.	Same as Alternative 1.	Same as Alternative 1.
Land Use			
Project Area	No changes from existing conditions.	May be modified if listed species are affected.	The PUD will consider cumulative effects of land use decisions, accept comments on such actions from signatory parties, and notify applicants of potential incidental take restrictions.
Associated Tributaries	Local and State aquatic habitat enhancement projects may alter floodplains and result in land exchanges. Less development would be allowed at river shorelines. No change from existing conditions.	Same as Alternative 1.	Same as Alternative 1, although more actions are expected under the tributary fund.
Columbia River System/Cumulative Effects	No change from existing conditions.	Same as Altemative 1.	Same as Alternative 1.

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	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Aesthetics			
Project Area	Projects viewed in rural setting.	Same as Alternative 1. Project conservation measures do not change scenic quality in the area. If drawdown occurs, substantial unvegetated barren earth would be seen in area of drawdown.	Same as Alternative 2.
Associated Tributaries	Tributaries occur in forested (higher elevation) and rural settings (lower elevations).	Same as Alternative 1.	Same as Alternative 1.
Columbia River System Cumulative Effects	Projects appear as man-made modifications to the Columbia River.	Same as Alternative 1. No developments planned in the area change the project scenic quality.	Same as Alternative 2.
Socioeconomics			
Project Area	No changes from existing conditions.	Electricity rates will go up as a result of higher production costs and the need to replace lost energy from more expensive generating plants. The amount of increase is based on the measures imposed on the PUDs. If drawdown is proposed, a detailed socioeconomic analysis would be conducted.	Less that Alternative 2 as the PUDs have the ability to implement the lowest cost measures to achieve defined survival standards.
Associated Tributaries	Short-term local jobs under independent tributary habitat improvements. No change from existing conditions.	Same as Alternative 1.	Same as Alternative 1, and Plan Species Account will provide some additional jobs and service-related income.
Columbia River System/Cumulative Effects	No changes from existing conditions.	Same as Alternative 1.	Same as Alternative 1.

COMPARISON OF ENVIRONMENTAL CONSEQUENCES (CONTINUED) **TABLE 2-9.**

	ALTERNATIVE 1		ALTERNATIVE 2		ALTERNATIVE 3	
Economics						
Cost in Millions (\$)	Wells	62	Wells	82	Wells	06
(Net Present Value)	Rocky Reach	237	Rocky Reach	358	Rocky Reach	261
	Rock Island	103	Rock Island	101	Rock Island	92
	Total	419	Total	541	Total	446
Foregone Power	Wells	77	Wells	785	Wells	86
Revenues in Millions (\$) (Net Present Value)	Rocky Reach	155	Rocky Reach	1,116	Rocky Reach	250
	Rock Island	29	Rock Island	587	Rock Island	221
	Total	299	Total	2,488	Total	569
Recreation						
Facility Operation and Maintenance	No changes from existing conditions.	ng conditions.	Same as Alternative 1. If drawdown occ reduced pool levels would make boat ral and beaches unusable and substantially impact recreational facilities.	Same as Alternative 1. If drawdown occurs, reduced pool levels would make boat ramps and beaches unusable and substantially impact recreational facilities.	Same as Altemative 2.	
Associated Tributaries	Short-term access may be affected as local and State aquatic habitat improvements occur through independent WRIA actions. No change from existing conditions.	be affected as local at improvements occur /RIA actions. No onditions.	Same as Alternative 1	.	Same as Alternative 1, although the additional PUD-funded habitat improvements could affect short-term access.	of the substant of the substan
Columbia River System/Cumulative Effects	No changes from existing conditions.	ng conditions.	Same as Alternative 1. If increased fishing upstrear of the projects may result.	Same as Alternative 1. If drawdown occurs, increased fishing upstream and downstream of the projects may result.	Same as Altemative 2.	

COMPARISON OF ENVIRONMENTAL CONSEQUENCES (CONTINUED) **TABLE 2-9.**

	ALTERNATIVE 1	AL TERNATIVE 2	ALTERNATIVE 3
Cultural Resources			
Project Area	No change from existing conditions.	Same as Alternative 1. If drawdown occurs, substantial impacts could occur to cultural resources.	Same as Alternative 2.
Associated Tributaries	Tributary habitat improvements that occur through independent actions could affect some cultural resources unless surveys and mitigation (if needed) are conducted prior to earth moving activities. However, regulatory compliance with applicable laws is expected.	Same as Altemative 1.	Same as Alternative 1, although additional PUD-funded habitat improvements would be expected.
Columbia River System/Cumulative Effects	No change from existing conditions.	No change would occur. If drawdown occurs, impacts could occur to cultural resources at downstream dams.	Same as Alternative 2.
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ESA = Endangered Species Act

Chapter 3

Affected Environment

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CHANGES MADE BETWEEN THE DEIS AND FEIS FOR CHAPTER 3

- New references were added throughout Chapter 3 to update the information provided in the DEIS.
- The Fisheries section was updated to state that critical habitat designations are being reevaluated by NMFS. This section now includes more information on the tributary habitat components of value to salmonids.
- Recent information on salmonid adult returns and fish counts was added.
- The spawning distribution of fall-run chinook salmon was updated.
- A discussion was added on hatchery fish that spawn naturally.
- The subsection on mitigation for unavoidable sockeye salmon losses at Wells Dam was updated.
- Additional information was provided on salmonid passage time rates, fallback rates, and survival improvements.
- Species information was updated for the following fish: bull trout, cutthroat trout, river lamprey, Pacific lamprey, kokanee, pygmy whitefish, white sturgeon, lake chub, smallmouth bass, leopard dace, mountain sucker, walleye, largemouth bass, rainbow trout, and mountain whitefish.
- New WDFW fishing regulations and information on recreational fishing in the project area were added.
- The Water Resources section includes new information on water temperature and total dissolved gas levels at Wells Dam.
- The Vegetation section includes an update on the Federally listed plant Ute ladies' tresses.
- The Wildlife section has a new subsection on piscivorous bird control activities.
- The Socioeconomics section includes new Tribal Demographics and Economics subsections.
- Additional Economics, Aesthetics, and Environmental Justice sections are now included in Chapter 3.

Chapter

3 AFFECTED ENVIRONMENT

This chapter summarizes the environmental resources within the Mid-Columbia River region, including the upland areas adjacent to the mainstem Columbia River and the four major tributaries (Okanogan, Methow, Entiat, and Wenatchee). The purpose of the chapter is to document both the existing conditions and the current effects that Mid-Columbia River hydroelectric project operations have on these resources. This information will be used in

Chapter 4 to assess the effects of project operations under the alternatives addressed in this EIS.

The specific resources discussed in this chapter include land features/geology/soils, fisheries resources, water resources (quantity and quality), vegetation, wildlife, land ownership and use, socioeconomics, economics, aesthetics, recreation, cultural resources, and environmental justice.

3.1 LAND FEATURES, GEOLOGY, AND SOILS

Key Terms

Basalt – A fine-grained, igneous rock dominated by dark-colored minerals. Cliffs along the Columbia River Valley are typically formed in basalt.

Channel Structure – Channel structure is formed by river bed roughness elements like bars and bends, in-channel logs or debris jams, bank vegetation, and large rocks. Channel structure is important for channel flow velocities, aquatic habitat, and prevention of channel erosion.

Columbia Plateau – Relatively flat region of eastern Washington and northern Oregon formed by vast accumulations of near horizontal flows of basalt lava.

Fluvial – Related to rivers or produced by river action, e.g., a fluvial plain or river bar.

Geomorphology – Branch of geology that deals with the form of the earth and earth surface and the changes that take place in river and hillside landforms.

Glacial – Related to or formed by a glacier. Extensive glaciers flowed into the Mid-Columbia River area, greatly influencing the river and valley landforms and geologic deposits.

Gneiss - Coarse-grained, metamorphic rock in which bands of differing mineral composition and texture appear.

Graben – An elongate, trench-like structural form bounded by parallel faults, created when the block that forms the valley floor moved downward relative to the blocks that form the sides of the valley wall.

Headwater Elevation – The average or maximum reservoir elevation at the project dam.

Physiographic Regions – Areas with similar landforms, geologic materials, soils, and climate.

River Terrace – Relatively flat areas formed by the rivers. Terraces near the rivers are active floodplains; higher terraces have been abandoned by river down-cutting and are no longer accessed by flood flows. Floodplain terraces are common locations for wetlands and side channels, important areas for storage of floodwaters, and important aquatic and wildlife habitat.

Schist – Medium- or coarse-grained metamorphic rock dominated by subparallel orientation of platy mica minerals.

Sediment – Clay, silt, sand, gravel, and cobbles that are deposited into layers by wind, ice, water, or gravity.

Structural Depression – Valley area formed by geologic faulting.

Tailwater Elevation – The average or minimum water elevation at the toe of the dam.

* See Chapter 7 for a complete listing of all Key Terms.

3.1.1 LAND FEATURES

3.1.1.1 Project Area

The three project area dams are located in the Columbia River valley between the Columbia Plateau and the Cascade Mountains. Watersheds to the west and north of the project areas include mountain streams flowing from the Wenatchee Mountains, the Chiwaukum and Methow structural depressions, the north Cascade Mountains, and the Okanogan Highlands. The watersheds to the east of the project areas are on the Waterville Plateau, which is the northwest portion of the much larger Columbia Plateau (Figure 3-1).

The associated tributary watersheds contributing to the project area include a broad range of terrain types, geologic materials, and climate regions, from high-elevation mountain peaks with glaciers to flat 3-mile-wide valley bottoms. Conditions vary from desert and steppe conditions in the eastern parts of the project watersheds, with as little as 7 inches of annual precipitation, to the snow-covered north Cascade Mountains to the west, with over 100 inches of precipitation annually.

Wells Dam

The Wells Dam, located at river mile 515.8, is the furthest upstream dam in the project area. The Wells Dam, constructed between 1963 and 1967, is the most recently built hydropower project on the Mid-Columbia River mainstem. The dam has a central reinforced concrete structure 1,130 feet long with earth and rock fill embankments on both sides. The east embankment is 1,030 feet long, and the west embankment is 2,300 feet long, for a total embankment length of 3,320 feet and a total dam length of 4,460 feet. The Wells Dam is the only hydrocombine (combined powerhouse and spillway structure) on the Columbia River.

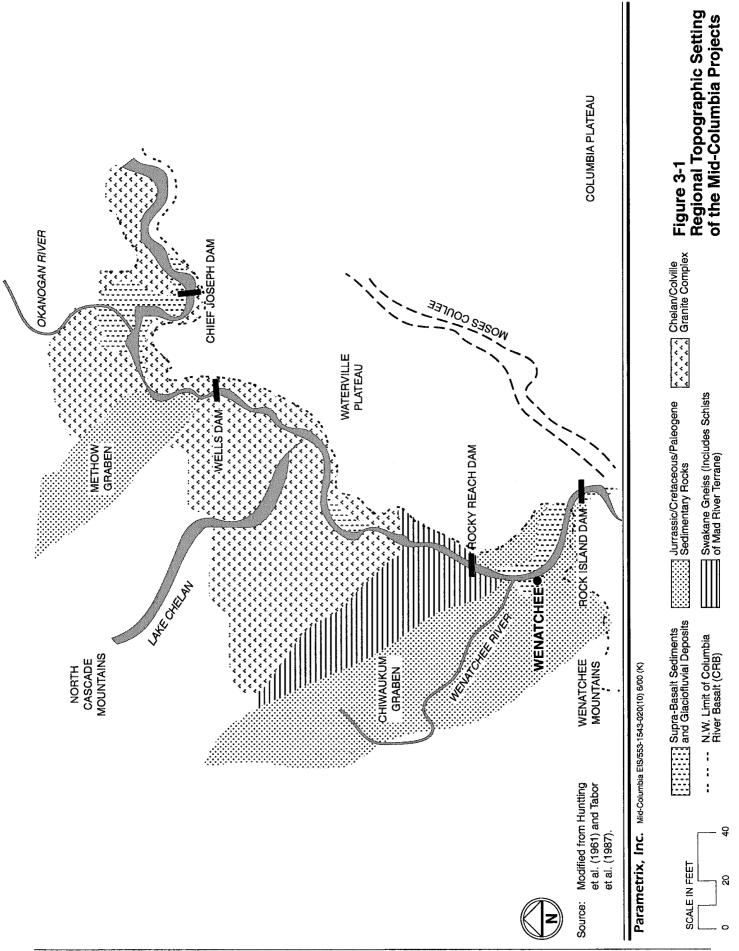
The valley floor is about 4,000 feet wide at the Wells Dam. The original river channel was about 700 feet wide against the east (left bank) valley wall (Galster 1989a). The east side of the valley (left bank) consists of a series of narrow terraces. The west side (right bank) consists of a terrace at 720 feet elevation that is about 2,000 feet wide, followed by a 2,000-foot-wide terrace going from 750 to 775 feet elevation, where it meets a steep bedrock face that serves as the west abutment for the dam. The valley bottom continues with another glacial-age terrace at an elevation of 880 feet and another at 1,200 feet elevation that meets the bedrock west valley wall.

The Wells reservoir extends from river mile 515.8 to the tailrace of Chief Joseph Dam at about river mile 545.5. The reservoir has an area of 9,740 acres and is between 1,300 and 8,000 feet wide, with an average width of 2,700 feet. The reservoir contains a total storage volume of 331,200 acre-feet with 97,985 acre-feet of usable storage at 10 feet of drawdown. The normal reservoir elevation is 781 feet, with a tailwater elevation of 703 feet. The dam has 10 units operating with a hydraulic head of 67 feet.

Rocky Reach Dam

The Rocky Reach Dam is located at river mile 474.5. The dam and original powerhouse with seven power units were constructed between 1956 and 1961. Four additional power units were added between 1969 and 1971. The Rocky Reach Dam is a Z-shaped structure with a spillway, powerhouse, and service bay. The dam is essentially a gravity structure that rises 218 feet above the lowest bedrock support at 499 feet elevation (Coombs 1989).

The valley bottom is about 5,000 feet wide at the dam site. The site consists of a left bank terrace, 140 feet above the river at low flows, that extends for 3,500 feet from the river to the valley wall cliffs (Coombs 1989). The dam rests on rock of the former channel that was about 1,000 feet wide at high flows. The west (right bank) side of the



dam is against the valley wall, which has shallow soil materials over bedrock.

The Rocky Reach reservoir extends from river mile 474.5 to the Wells Dam tailrace at about river mile 516. The reservoir has an area of 8,235 acres with a width of 1,500 feet to over 5,000 feet. The reservoir contains a total storage volume of 412,000 acre-feet, with 36,400 acrefeet of usable water storage at 4 feet of drawdown. The average project headwater elevation is 706.5 feet, with an average tailwater elevation of 617.5.

Rock Island Dam

The Rock Island Dam, located at river mile 453.4, is the furthest downstream dam in the project area. The dam, powerhouse, and first four turbine units were constructed between 1930 and 1933. The Rock Island Dam was the first dam to be built on the Columbia River mainstem. Additional work continued on the powerhouse and six additional turbine units were constructed between 1951 and 1953. A second powerhouse with eight turbine units was built between 1974 and 1979. Rock Island Dam is a reinforced concrete structure 3,600 feet long with a deck-top elevation of 616 feet and a total hydraulic head of 36 feet.

The valley bottom is about 7,000 feet wide at the dam site. Original selection of the site was based on the availability of shallow bedrock at one of the five major Columbia River rapids: Rock Island rapids (Galster 1989b). The Rock Island rapids were formed by a flat-topped mass of basalt called Rock Island. Part of this island is still visible at the dam site. The rapids were positioned against the east (left bank) side of the valley due to the deposition of a large glacial-age terrace on the west side of the valley. At low flows, the Columbia River channel was originally 200 feet wide on either side of Rock Island; at flood flows, the entire dam site area was underwater.

The Rock Island reservoir extends from river mile 454 upstream to the Rocky Reach tailrace at about river mile 474. The reservoir is 3,300 acres in area, with a typical width of 1,500 feet. The reservoir has a total storage volume of 130,000 acre-feet, with 12,480 acre-feet of usable storage at 4 feet of drawdown. The normal project pool elevation is 612.6 feet, with an average tailwater elevation of 573.2 feet.

3.1.1.2 Associated Tributaries

The main tributary watersheds can be divided into three typical physiographic regions that have a similar range of landforms, geologic materials, soils, and river processes: (1) the mountainous regions of the western and northern tributaries, (2) the valley bottom areas in the lower portions of the tributaries, and (3) the Columbia Plateau region east of the Columbia River valley.

The tributaries originate in the high Cascade Mountains of the U.S. and Canada. Major tributary rivers in this physiographic region include the upper portions of the Wenatchee, Entiat, Methow, and Okanogan Rivers. Climatic conditions range from extreme alpine and subalpine in the upper basins to wet and dry forests in the foothills. Precipitation ranges from 25 inches to over 140 inches per year in the upper Wenatchee Basin, from 35 to 80 inches per year in the upper Entiat Basin, from 15 to 80 inches per year in the Methow Basin, and from 30 to 40 inches per year in the upper Okanogan Basin. Snowmelt and rainfall run-off from this region is a major source of water for hydroelectric power, irrigation, and instream flows. The mountain areas are characterized by steep hillslopes with very high- to moderate-gradient tributary creeks. Limited flat areas occur along the valley bottoms, on ancient and recent river terraces, and in floodways.

The second typical physiographic zone, the valley bottoms, is in the lower portions of the western and northern tributary valleys, where glaciers and the tributary rivers have eroded deep, relatively wide valleys. Climate, soil, and vegetation conditions include dry forests, grass steppe, and shrub steppe. Precipitation in the lower tributary valleys ranges from 7 to 15 inches per year. This area is characterized by steep, rolling hills along the valley walls, with flat to moderate slopes on ancient terraces and along the valley bottoms. Stream gradients are from high to moderate in the lower valleys.

The third main physiographic zone, the Waterville Plateau, includes the plateau and tributary streams east of the Columbia River valley and the area southwest of Omak Lake. The main tributaries from this region include Omak, Douglas, Foster, and Rock Island Creeks. Climate, soil, and vegetation conditions include grass steppe, shrub steppe, and desert. Average precipitation is 10 inches per year. Tributary flows are considerably less from the Waterville Plateau compared to the run-off from the Cascades.

Wenatchee River Valley

The Wenatchee River enters the Columbia River at river mile 468.2, about 15 miles upstream of the Rock Island Dam and 6 miles downstream of the Rocky Reach Dam (see Figure 1-2). Its watershed covers an area of 1,328 square miles. The river itself begins at Lake Wenatchee in the Cascade Mountains. The Wenatchee Mountains form the southern portion of the watershed, the north Cascade Mountains form the western portion, and the Entiat Mountains form the northern portion of the watershed. Elevations range from 615 feet at the river mouth to just over 8,500 feet at the highest upper watershed peaks.

Entiat River Valley

The Entiat River enters the Columbia River at river mile 484, about 10 miles upstream of the Rocky Reach Dam (see Figure 1-4). With a watershed area of 419 square miles, this is the smallest watershed of the four main tributaries.

The south side of the basin is formed by the Entiat Mountains. The Chelan Mountains form the northern portion of the watershed, and the north Cascade Mountains form the western portions. Elevations range from 708 feet at the river mouth to just over 9,000 feet at the highest upper watershed peaks.

Methow River Valley

The Methow River enters the Columbia River at river mile 523.9, about 7 miles upstream of the Wells Dam (see Figure 1-5). The Methow River has a watershed area of 1,791 square miles. Sawtooth Ridge marks the southwest side of the basin. The northern portions are in the Pasayten Wilderness, and the north Cascade Mountains form the western portions of the basin. Elevations range from 780 feet at the river mouth to just under 9,000 feet at the highest upper watershed peaks.

Okanogan River Valley

The Okanogan River begins near Armstrong, British Columbia and flows south through a series of lakes to the Columbia River; it enters the Columbia River at river mile 533.5, about 17 miles upstream of the Wells Dam (see Figure 1-5). The Okanogan watershed covers an area of about 8,200 square miles, 2,342 square miles of which occur in the United States. The northern portion of the watershed is in the Okanogan Highlands of the U.S. and Canada. The southern part of the basin near the river mouth is in the northwest corner of the Columbia Plateau. Elevations range from 780 feet at the river mouth to over 8,400 feet at the highest upper watershed peaks.

3.1.1.3 Columbia River System

The Columbia River has a watershed area of 259,000 square miles, with 39,000 square miles in Canada. The Columbia Basin includes physiographic provinces in both the U.S. and

British Columbia, including parts of the Pacific border, Cascade Range, Columbia Plateau, northern Rocky Mountains, and middle Rocky Mountains (U.S. Geological Survey [USGS] 1994). The overall watershed is bounded by the Rocky Mountains on the east and the Cascade and Coast ranges on the west. The Basin includes 100,000 square miles of the Columbia Plateau. The Columbia River is about 1,243 miles long, with 91 miles located within the project area.

The project dams and the main Mid-Columbia River tributaries are located in the rain shadow of the Cascade Range and have arid to semi-arid climates, low precipitation, dry summers with warm to hot temperatures, and cold winters. Average precipitation in the entire Columbia River Basin is less than 20 inches annually, with much of this occurring in the winter. Some marine influences occur in the alpine zones of the Cascades where as much as 40 to 140 inches of precipitation occurs, mostly as snow. Higher precipitation amounts (40 to 100 inches/year) also occur in the lower river from the Pacific Ocean to the Columbia Gorge because of the marine influence, and in the mountain ranges of Idaho and Montana because of elevation.

Major dams in the Columbia River Basin (with active water storage over 5,000 acre-feet) include 20 in Montana, 48 in Idaho, 33 in Washington, 45 in Oregon, and 16 in Canada (USGS 1994).

3.1.2 GEOLOGY AND GEOMORPHOLOGY

Under the Federal Power Act, hydroelectric projects are reviewed and inspected by FERC staff and contractors to confirm that project structures are stable and safe and determine whether geologic hazards may threaten the facilities or public safety. These inspections are ongoing, and include (when needed) sampling and analysis for seismic hazards, spillway capacity, landslide potential, and erosion issues.

3.1.2.1 Project Area

The Cascade Mountains and Okanogan Highlands to the west and north of the project area include a mix of granitic, volcanic, metamorphic, and sedimentary rocks that have been added onto the North American continent by plate tectonic motions and deposition of material eroded from uplifted areas. Great regional ice sheets and local alpine glaciers modified the mountain areas and tributary valleys. Glacial and alluvial deposits fill the valley with up to several hundred feet of sediment forming extensive terraces along the valley edges. Sediment transported from the mountains and reworked from the valley fills the current floodway and channel deposits along the river valley bottoms.

The project area dams are in a portion of the Mid-Columbia River that can be divided into three basic geologic segments. Between the mouth of the Okanogan River and the Wenatchee River, the Columbia River runs in a deep, steep-walled valley cut into the granitic and gneissic rocks of the northeastern Cascades. Two of the project dams and reservoirs, Rocky Reach and Wells, are within this segment of the Mid-Columbia River. The Okanogan, Methow, and Entiat valleys are also in this geologic region.

The second geologic segment runs for several miles downstream from the Wenatchee River; softer sedimentary rocks of the Chiwaukum graben underlay it. Most of the rocks in the Wenatchee River Basin are in the same sedimentary rock formation, the Chumstick formation.

The third geologic segment along the Mid-Columbia River begins about 5 miles downstream of the Wenatchee River, where the river approaches the north side of the Wenatchee mountain uplift. Here the river is deflected about 10 miles eastward onto the lava plateau underlain by the Columbia River basalts. The river has cut a 600-foot-deep canyon into the Columbia

Plateau basalts. Rock Island Dam is in this portion of the Mid-Columbia River.

Wells Dam

The Wells Dam site was selected because of the presence of bedrock on either side of the valley about midway between the downstream Rocky Reach Project and the upstream Chief Joseph Dam. Prior to construction, the river channel was 700 feet wide located against the east valley wall (Figure 3-2) (Tabor et al. 1982; Galster 1989a). The floodplain west of the river is about 1,000 feet wide.

Additional ancient terraces of glacial, alluvial, and lake deposits occur on the west side of the valley. Bedrock beneath the ancient west bank terraces is about 200 feet lower than the historic river channel. The east side of the valley rises sharply in a series of glacial and fluvial terraces backed by granitic rock slopes that are capped by the basalt beds of the Waterville Plateau, 2,000 feet above the valley floor. The east side of the dam is an embankment 1,000 feet long, with underlying glacial and alluvial sediments on granitic bedrock. The west side of the dam is an embankment 2,300 feet long, with underlying layers of glacial and alluvial sediments as thick as 200 feet to granitic bedrock. The dam (spillway, powerhouse, and fishladders) is built on granitic bedrock cut by north trending basic igneous dikes (Galster 1989a).

The dam site and reservoir valley floor is underlain by a sequence of glacial and fluvial deposits consisting of gravel and sand with local cobble and boulder units, and silty, sandy gravel with lenses of fine sand and silt lake deposits (Galster 1989a). The construction of upstream dams, beginning in 1955 with Chief Joseph Dam, cut off the main supply of upstream bedload sediment into the Wells reservoir. The main source of sediment into the reservoir is now from the tributaries, the majority coming from the Methow and Okanogan Rivers. Sand and gravel deposits occur near the mouths of each tributary,

with silt and sand being deposited in the reservoir further away from the tributary inputs.

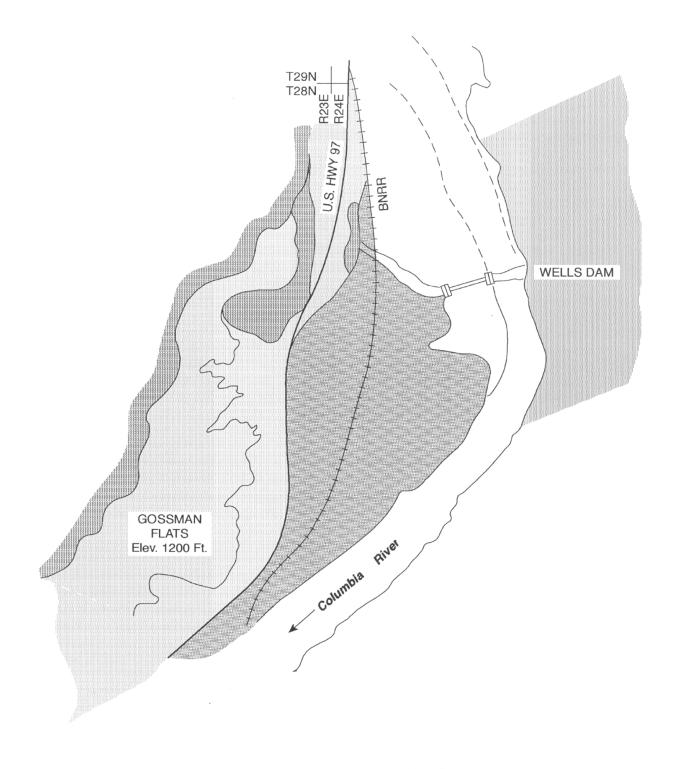
Rocky Reach Dam

The mountains to the north and to the west and the bedrock under the Rocky Reach Dam are all in the Swakane biotite gneiss (Figure 3-3) (Waters 1932; Tabor et al. 1987). On the east bank, the Swakane gneiss forms a cliff 2,000 feet above the river; the cliff is capped by the Columbia River basalts at the western edge of the Columbia Plateau (Coombs 1989). An east bank terrace surface 140 feet above the low-flow river extends 3,500 feet from the river's edge to the valley wall cliff (see Figure 3-3). Exploration during construction revealed a thin layer of sediments over bedrock in the river bottom at the historic river channel location. Beneath the large terrace on the east bank, the bedrock surface is 130 feet lower than the historic channel location. The terrace consists of a layer of coarse gravels from a few feet to more than 100 feet thick, directly overlying the bedrock. Above the gravels is a varved (thin-bedded) lake bottom clay 180 feet thick. In some locations, the clay layer has been eroded away by the river. Above the clay layer are fluvial deposits of sand and gravel.

The supply of upstream bedload sediment into the Rocky Reach reservoir was cut off 5 years after completion of the dam, following the construction of the Wells Dam. The main source of sediment into the reservoir is the Entiat River. Sand and gravel deposits occur near the mouths of the tributary, with silt and sand being deposited in the reservoir further away from the tributary inputs.

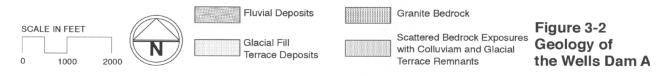
Rock Island Dam

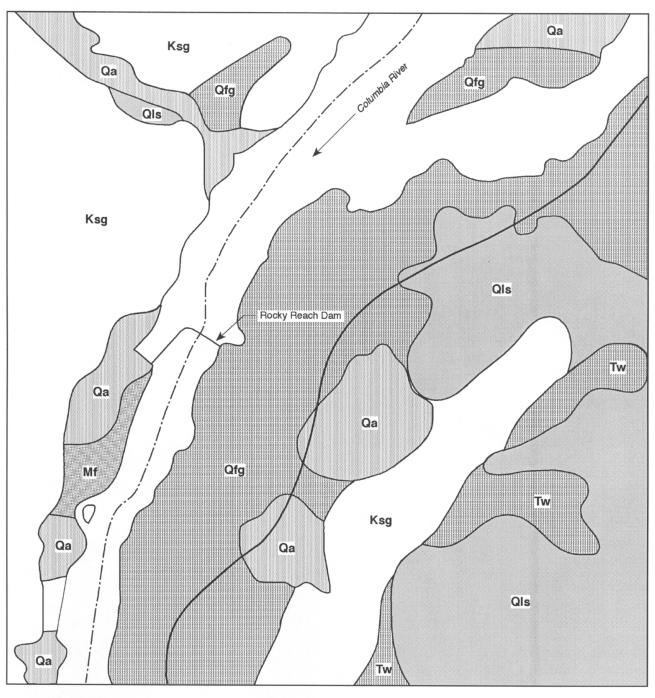
At the site of the Rock Island Dam, anticlinal ridges of the Wenatchee Mountains forced the Columbia River to the east, where it cut into the generally level Columbia River basalts. The original Rock Island rapids and Rock Island are positioned hard against the east side of the



Source: Galster, 1989.

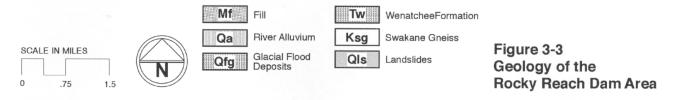
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Source: Galster, 1989.

Parametrix, Inc. Mid Columbia/553-1543-020(10) 6/00 (K)



Columbia River valley due to deposition of extensive glaciofluvial deposits from glacial and great flood events (Galster 1989b) (Figure 3-4). The dam, powerhouse, and spillway are built on basalt and tuffaceous bedrock.

The Columbia River valley was about 6,000 feet wide at the dam site and much wider upstream near Wenatchee prior to being filled with several hundred feet of sand and gravel during the great Missoula floods. This forced the river onto higher bedrock on the east side of the valley, thus creating the Rock Island rapids. The great floods flowing out of Moses Coulee deposited sediment both up- and downstream. The flood deposits form a terrace to the west, upstream, and downstream along the river, consisting primarily of sand and gravel with cobbles, boulders, and thin layers of silt and clay. The bedrock surface is deeper under the terrace than at the dam site. The terrace surface, over 200 feet above the riverbed, has numerous ice-rafted basalt blocks up to 20 feet in diameter.

The glacial and great flood deposits underlay the reservoir and form the reservoir and former Columbia channel banks. The river reworked these glacial deposits along the former floodway, forming sand and gravel alluvial deposits.

Alluvial sediment, transported by the Columbia River prior to construction of the Rocky Reach Dam (29 years after the Rock Island Dam was constructed), deposited in the upper end of the Rock Island reservoir. Sand and gravel occur in the upstream portions of the reservoir with sand and silt being deposited in the downstream portions. Additional sediment is deposited in the reservoir in the form of a delta where the Wenatchee River enters the reservoir.

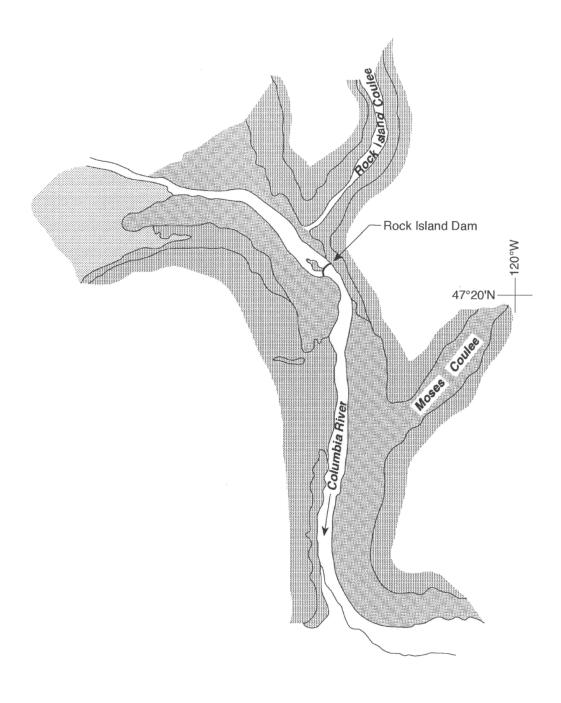
Suspended sediment transport in the Mid-Columbia River is relatively low (BPA et al.1994a). Each upstream reservoir allows a portion of the seasonally high suspended sediment loads from the Upper Columbia River to

settle out during transit. Direct input of fines from the tributaries is now the main source of silt and fine sand into the Rock Island reservoir. Typical water and suspended sediment travel rates through the Mid-Columbia River are between 1 to 4 feet per second at flows of 100,000 to 380,000 cubic feet per second (cfs) respectively (NMFS et al. 1998a). This allows fine particles in the water column to settle at a higher rate than if natural current velocities occurred. The fine sediment deposits on the bottom where it is often reworked by slumping off the steep reservoir edges and by higher velocities that occur during extreme flood flows. This tends to move the deposited clay, silt, and fine sand into the deeper portions of the reservoir.

3.1.2.2 Associated Tributaries

The range of watershed and river channel conditions is quite similar for all of the main tributary rivers. The river channels in each of the tributaries receive sediment delivered by creeks, mass-wasting, and surface erosion. The steep mountain conditions and presence of glacial deposits result in high sediment delivery rates to the upland creeks. The high gradient mountain streams of the upper watersheds have a large and coarse textured bedload that is deposited onto alluvial fans and channel bars along the main river floodways. Additional channel sediment is eroded from the banks in natural channel migration and erosion of alluvial, glacial, or residual soils along the rivers.

Depending on flow conditions, a portion of the sediment that enters the creeks is transported downstream and a portion is stored along the channel in the channel bars, on the banks, and overbank on the floodplain. Fine sediment is derived from reworking of the glacial and valley bottom deposits by the creeks and from sheet wash erosion of bare areas in the watershed.



Source: Galster, 1989.

Parametrix, Inc. Mid Columbia/553-1543-020(10) 8/02 (K)









Grande Ronde Basalt

Figure 3-4 Geology of the **Rock Island Dam Area** Vegetation (including standing and fallen trees) along with stream banks, brush, forbs, and grasses all play an important function to tributary channel conditions; they protect the banks and provide instream diversity that is important to aquatic and riparian habitat conditions. Depending on the land use and development history, various portions of the tributary creek and river channels have been modified from natural conditions by flood impacts, forest harvest, fires, transportation right-of-ways, and land modifications related to agricultural, residential, and urban development.

Wenatchee River

The Wenatchee River valley is formed in the softer sedimentary rocks of the Chumstick formation preserved in the structural basin referred to as the Chiwaukum graben (Cheney 1994). The Chumstick formation consists of folded shale, sandstone, and conglomerate. The Leavenworth fault zone is on the southeast boundary of the Chiwaukum graben. The metamorphic rocks of the Swakane gneiss are across the Entiat fault on the northeast side of the graben. Glaciation in the northern portion of the basin has resulted in a thick mantle of till overlying lower ridges and valley walls (U.S. Forest Service [USFS] 1999). The entire southern section of the watershed escaped glacial modification.

The Wenatchee River begins at Lake Wenatchee. The Little Wenatchee River and White River flow into the northwest end of the lake. Numerous very high-gradient mountain streams with falls, cascades, and step-pool channels flow from the steep valley walls around the lake. The Lower White and Wenatchee Rivers have a gradient of approximately 1 percent and are slightly entrenched in wide glacial valleys. Large woody debris and channel pool conditions are average. Sediment transport rates are highest in the White River due to the transport of glacial material, including the transport of glacial flock during low-flow conditions. Sediment transport rates in

Little Wenatchee River are also high, especially during flood events. Most of the sediment delivered to the lake is deposited in the lake as deltas, alluvial fans, and lake bottom sediments.

Nason Creek and Chiwawa River join the Wenatchee River at the outlet of Lake Wenatchee (river mile 53.6). Nason Creek flows through a glacially formed canyon with a gradient of less than 1 percent in the lower portion. Some side channels have been cut off by Highway 2, and over 5 percent of the lower channel has riprapped banks. The Chiwawa River is the largest Wenatchee River tributary. The river channel is dominated by riffle habitat, with pools primarily associated with log jams and meanders. The channel does not meet the USFS standards for large woody debris or pools (USFS 1992).

From the lake to Chiwawa River, the Wenatchee River cuts through a glacial outwash plain with a pool-riffle channel composed mainly of cobble and gravel substrate. Large, deep pools are relatively frequent. From Chiwawa River to the Tumwater Canyon, the Wenatchee River is a pool-riffle and plane-bed channel with further entrenchment, increased gradient, and fewer pools compared to upstream areas. Substrate is also coarser than upstream areas, with more boulders and cobbles as a result of the steeper gradient and confinement of the channel.

Tumwater Canyon is a non-glaciated portion of the valley that the Wenatchee River passes through. Hillslopes are steep igneous and metamorphic rocks forming a deep, narrow, V-shaped valley. The channel is pool-riffle and step-pools with a gradient of less than 2 percent. Long, deep pools alternate with steep riffles. Alluvial and debris fans form along the channel where very high-gradient tributary creeks flow into the canyon. The channel in the canyon has been modified due to railroad, highway, and dam construction. Large bed elements and large woody debris sources were removed for historic log drives down the river, resulting in higher

velocities, fewer pools, and reduced structure to the canyon channel.

Chiwaukum Creek joins the Wenatchee River at river mile 35.9. It is a pool-riffle channel at its mouth, a steep-pool channel in the middle reaches, and is dominated by cascades in the upper reaches. Large log jams and cobble/boulder substrate contribute to a stable channel condition. Loss of riparian vegetation has increased stream bank erosion.

Icicle Creek at river mile 25.6 and Chumstick Creek at river mile 23.5 join the Wenatchee River at the town of Leavenworth. Both creeks are unconfined low-gradient streams. Icicle Creek has extensive bank rip-rap, and a substantial amount of riparian vegetation has been removed (Chapman et al. 1994a). Side channels and oxbows of the original streamway have also been cut off from the main channel. Chumstick Creek has been straightened and realigned along much of the channel. It has a high percentage of silt in the lower 9 miles and is a source of sediment to the Wenatchee River. Several culverts alter the channel conditions, including one that is a fish passage barrier at the river mouth.

In the Upper Wenatchee River watershed, more than 2,500 miles of trails and 4,700 miles of roads provide access to the Wenatchee National Forest. Portions of these roads impact the creek and river channel conditions. Forest practice impacts are minor in Icicle Creek watershed, but are significant in the other tributary watersheds (NMFS et al. 1998a). Forest roads in the Peshastin and Chumstick watersheds are often located in the narrow floodplains of the creeks, encroaching into the streamway, reducing riparian canopy, modifying rain and snowmelt run-off, and increasing fine sediment loads to the creeks, all of which have altered stream channel conditions. Fine sediment levels in the river substrate are above the USFS standard (20 percent) in Mission, Peshastin, and Tronsen Creeks (NMFS et al. 1998a). Many of the timber harvest areas in these watersheds were cut prior to

1988, when no stream riparian buffers were required. At that time, fish-bearing streams had minimal buffers that are now known to be inadequate for the full range of riparian zone functions.

Increased recreation along the White and Chiwawa watershed creeks has resulted in substantial amounts of wood harvest by campers (NMFS et al. 1998a). This causes local bank erosion, loss of large woody debris, and channel sedimentation.

The wide lower-gradient valley of the Wenatchee River begins at Leavenworth. A glacier from the Icicle Creek drainage deposited a moraine across the valley that filled and widened the valley, resulting in a sinuous, unconfined, pool-riffle channel. The channel form would naturally be controlled by overbank flows and channel migration. This has been limited by rip-rapped banks to protect floodplain development. Flows are concentrated in the channel, causing channel incision and bed form changes.

The Lower Wenatchee River was originally unconfined, meandering, and had considerable channel structure with extensive side channel areas. The relatively uniform channel is now moderately entrenched with a moderate, riffledominated gradient. The channel conditions have been modified as a result of extensive floodplain development along the lower 12 miles of the river. Orchards, homes, and roads now occupy much of the channel riparian zone.

Peshastin and Mission Creeks are the largest tributaries to the Lower Wenatchee River.

Peshastin Creek enters about a mile below the town of Peshastin, and Mission Creek runs through the town of Cashmere. Peshastin Creek has been straightened and realigned along much of the channel due to the construction of Highway 97, and much of the riparian vegetation has been removed and modified in many areas, resulting in poor bank protection and a lack of large woody debris. These changes result in higher water

velocity rates and unstable channel substrate conditions. Peshastin Creek was extensively placer mined between 1860 and 1940, with some mining still occurring today. Historically, this resulted in almost total loss of the stream channel and floodway. Current practices primarily impact the streambed and banks. Because of the potential financial income from small-scale dredging for gold in creeks, the potential for impacts to the creek channels is significant. Small-scale digging and dredging is increasing the instream foot traffic and substrate disturbance in and along the creek channels in areas with known placer deposits such as Peshastin Creek.

Historically, Mission Creek was heavily grazed, and some impacts to run-off and sediment supply continue to occur. Mission Creek is one of the two main sources of sediment to the Lower Wenatchee River (NMFS et al. 1998a). Roads encroach into the streamway of Mission Creek, with similar channel impacts as seen in the upper watershed tributaries.

An inventory of the Wenatchee River from Icicle Creek to the mouth, based on 1991 conditions, indicated a high level of bank disturbance. Of the 57 miles surveyed, 31 percent had no woody vegetation, 35 percent had only a narrow woody buffer zone, 19 percent of the stream banks were armored with rip-rap, and only 16 percent had intact natural woody vegetation (NMFS et al. 1998a). Most of the channel alterations are the result of railroad, highway, and road construction along the Wenatchee River and the Nason, Peshastin, and Chumstick Creeks. Highway encroachment into the streamway and channel migration zone has cut off the side channel areas in the Sleepy Hollow reach of the lower river. Extensive use of rip-rap along the Lower Wenatchee River has decreased the channel sinuosity and reduced the potential for large woody debris recruitment (NMFS et al. 1998a).

Entiat River

The Entiat River valley is formed in the metamorphic rocks of the Swakane gneiss (Cheney 1994). The Entiat fault runs along the southwest side of the valley. A mix of igneous rocks composing the Chelan Mountains forms the northeast side of the valley.

The Upper Entiat River channel begins at the Entiat glacier (river mile 53). The upper river reaches are high-gradient, non-fish-bearing mountain channels. The middle reach begins at about river mile 44. The upper portion of the middle reach (from river mile 44 to river mile 33) has typical channel gradients between 4 and 10 percent. This portion of the river has entrenched, cascading, and step-pool channels. Substrate is cobble and gravel. Steep valley slopes provide abundant sediment and woody debris supply. Sediment transport rates are high because of the high channel gradients.

Channel modifications related to land use and management influences have been relatively minor in the middle reaches of the river. The middle portion of the middle reach (from river mile 33 to river mile 25 near the USFS boundary) has channel gradients between 2 and 4 percent. Here the channel is moderately entrenched and dominated by riffles with infrequently spaced pools. Much of the stream channel below the USFS boundary has been channelized and riprapped, with large woody debris and bank vegetation removed. There has been a 30 to 60 percent loss of pool areas in this segment since a survey conducted in the 1930s (USFS 1996).

Historic and current management influences to the channel have been significant, including grazing, fires, roads, recreation, and timber harvest. The lower portion of the middle reach (river mile 25 to river mile 16.5) is a lowergradient (less than 2 percent) meandering, point bar, and riffle-pool alluvial channel. A terminal glacial moraine at the Potato Creek confluence (river mile 16.5) controls the lower gradient and channel form in this portion of the river. Because of the lower channel gradient, there is a greater tendency for sediment deposition.

Following major floods in the 1940s and 1970s, nearly all of the lower 22 miles of the river channel were modified by dikes and road fills built to protect properties in the floodplain. This constrains the channel, reduces meandering, increases flow velocity, modifies channel bars and substrate, and reduces channel structure. Woody debris is often removed by landowners concerned about flooding, which further modifies the channel form.

The Lower Entiat River, from the Potato Creek moraine at river mile 16.5 to the river mouth, is an entrenched, meandering, riffle-pool channel with gradients less than 2 percent. Similar to the lower part of the middle reach, this portion of the stream channel has been modified by dikes, road fill, and encroachment. The amount of large woody debris is low and pools have been reduced by 90 percent since the 1930s survey.

Methow River

The Methow River is located in a fault-bounded graben underlain with highly folded sedimentary and volcanic rocks (McGroder and Miller 1989). The area lies between the Gardner mountain fault and the Pasayten fault. The sedimentary rocks weather easily compared to the granites and typically lie beneath thick glacial deposits. Upper valley areas are steep mountains in the Chelan/Colville granitic complex. Pleistocene glaciation has scoured the entire Methow River valley (Soil Conservation Service 1980).

The Upper Methow River begins in very high gradient confined mountain channels in the north Cascade Mountains. The streams in the headwaters of the basin are valley wall creeks that have steep to very steep gradients, are entrenched, cascading, steep/pool channels with bedrock, cobble, and gravel substrates. The headwater channels grade into moderately entrenched,

moderate-gradient, riffle-dominated channels with cobble and gravel substrates. The Upper Methow channel, from river mile 83.2 to river mile 74.5, has a typical gradient between 2.6 and 2.8 percent. The channel here is moderately entrenched and riffle-dominated, with infrequent pools. Substrate is cobble and gravel. Steep valley wall slopes provide large woody debris and sediment to the valley bottom alluvial fans. From river mile 74.5 to river mile 63.2, the channel gradient changes from 1.3 to 0.6 percent, and the channel is a meandering and braided alluvial channel with point and transverse bars. The substrate is cobble and gravel.

There is a moderate supply of large woody debris in the Upper Methow channel. Pool frequency is generally low because of the relatively high bedload transport rates and the moderate supply of large woody debris (USFS 1997). The riparian zone is fairly wide and undisturbed (NMFS et al. 1998a). Sediment delivery to the Lower Methow River is not a significant problem. The USFS estimates that sediment delivery to the Methow River from public lands is about 10 percent higher than natural background levels (Okanogan National Forest 1998). The riparian zones in the upper reaches of the Methow Basin are in relatively good condition, with only isolated damage from natural events and limited agriculture, grazing, logging, and roads (NMFS et al. 1998a).

The Mid-Methow River Basin area includes the mainstem from about 5 miles southeast of the town of Mazama to the river mouth. The Methow River is in a U-shaped, unconfined, alluvial valley from Mazama to river mile 32.5. Wolf Creek enters 2 miles upstream of the town of Winthrop, and the Chewuch River enters at Winthrop. The Wolf Creek watershed originates on the south side of Gardner mountain at 8,897 feet elevation, the highest point in Okanogan County. The Methow River is in a U-shaped, moderately confined, alluvial valley from river mile 32.5 to river mile 22.4 near the town of

Carlton. The Chewuch River, the largest Methow River tributary, enters in this segment.

From the confluence of the Chewuch River downstream, the Methow River has an average gradient of 0.37 percent. Past use of private bottom lands by livestock and agriculture has impacted about 60 percent of the Methow River channel by erosion, stream bank sloughing, and bank cutting. About 25 percent of the stream banks have been modified and over 60 percent are eroding (NMFS et al. 1998a). This impacts riparian vegetation, stream bank condition, channel pools, and cover conditions.

Roughly half of the Chewuch River Basin (primarily the upper basin) is relatively undisturbed with natural channel conditions. Along the Chewuch River for 18 miles below the National Forest boundary to Sheep Creek, there is a lack of large woody debris as a result of stream cleanouts for flood control, salvage of instream wood, and extensive logging along the stream riparian zone. Impacts to the channel along portions of the Lower Chewuch River occurred following the 1948 flood, when bank protection was added. Sediment delivery is a significant problem in the Lower Chewuch River. Impacts from forest roads have occurred along the Chewuch River and tributaries (Boulder, Cub, Falls, Twentymile, and Lake Creeks). Boulder Creek watershed has experienced several masswasting events, and significant bank erosion presently occurs in the lower 25 miles of the Chewuch River. Reduced large woody debris in the Lower Chewuch River results in reduced pool areas.

The Twisp River enters at river mile 40.2 at the town of Twisp. The Twisp River gradient ranges from 1.7 to 5 percent in the upper reaches and from 0.7 to 1.7 percent in the middle and lower reaches (USFS 1995). Substrate consists of gravel and sand. Forest roads located in the narrow floodplains of the Poorman, Newby, Little Bridge, Buttermilk, Canyon, and Lime Creeks (tributaries of the Twisp River) have impacted

channel conditions by direct damage to the riparian zone vegetation and side channel areas and introduction of fines from the road surfaces. The Canyon, Poorman, Little Bridge, Slate, and West Fork Buttermilk Creeks have degraded riparian areas that impact the channel condition by bank erosion and reduce channel structure because of the lack of large woody debris supply.

Surveys of the Twisp River indicate moderate large woody debris conditions. The better aquatic habitat conditions were found in the relatively undisturbed portions of the Twisp River that had good large woody debris and boulder cover. Reduced large woody debris in the Lower Twisp River results in reduced pool areas.

The Lower Methow River Basin area includes the mainstem from the town of Carlton to the river confluence with the Columbia River. The Methow River is in a U-shaped, confined, alluvial valley from near Carlton to river mile 6.5 and in a U-shaped, moderately confined, alluvial valley from river mile 6.5 to the mouth. The substrate quality in the mainstem Methow River is relatively good (Chapman et al. 1994a). Many channel sections are constrained by rip-rap or channel incision, resulting in a narrower deeper flow during flood flows and less room for channel migration. Many of the tributary streams to the lower Methow River, including Beaver, Gold, and Libby Creeks, have water rights that have been overappropriated resulting in dewatering of the streams in the summer and early fall. Vegetation clearing and stream bank rip-rapping has occurred where more homes were constructed along the valley bottoms. Over 86 percent of the channel has eroded and/or excavated banks or is channelized. Stream bank erosion is higher in residential and agricultural areas adjacent to the stream banks (USFS 1998). Construction of valley bottom roads and timber harvest have left small to nonexistent stream buffers that do not provide adequate stream bank protection or provide for current and future large woody debris input to the channels. Similar to the lower portions of the tributaries, reduced large woody

debris in the Lower Methow River has resulted in reduced pool habitat.

Okanogan River

The Okanogan River valley is a part of the Colville complex of granitic and metamorphic rocks. The Omak Lake fault runs up the Okanogan valley. West of the fault is a mix of igneous plutons, gneiss, and metamorphosed deep ocean sediments of the Okanogan trench deposit. These include argillite, phyllite, volcanic rocks, limited carbonate rocks, and greenstone. The valley has a thick deposit of glacial deposits over the bedrock. On the east side of the basin, east of the Omak Lake fault, the rocks are part of the Okanogan metamorphic core complex (Cheney 1994), basically an intrusive granitic dome and surrounding metamorphic gneiss.

Nearly all of the subbasin experienced glaciation and is characterized by moderate slopes and broad, rounded summits. In the lower valleys, the great regional ice sheets, local alpine valley glaciers, and the tributary rivers have eroded deep, relatively wide valleys. This area has steep to rolling hills along the valley walls, with flat to moderate slopes on ancient terraces and along the valley bottoms.

The Okanogan River originates in British Columbia with 29 percent of the watershed area in the United States. The Similkameen River, which enters the Okanogan River from the northwest approximately 75 miles above the mouth, is the main tributary and is located primarily in Canada. The Similkameen River is impassable at Enloe Dam, an abandoned power generation facility, 8.8 miles above the confluence with the Okanogan River.

The Lower Okanogan River runs south from Osoyoos Lake at the Canadian border. From river mile 77.6 at Zosel Dam to river mile 64.6 at Mosquito Creek, the unconfined valley is filled with lake bottom sediments. The channel has a gradient of 0.03 percent, with multiple channels

and eroded banks. From Mosquito Creek (river mile 64.6) to Aeneas Creek (river mile 52), the river valley is also unconfined. The channel gradient is 0.04 percent, with multiple channels and eroded banks. From river mile 52 to McAllister rapids at river mile 42 (12 miles upstream of Omak), the channel is in a moderately confined, alluvial valley. The channel gradient is 0.05 percent with multiple channels and eroded banks. From McAllister rapids to the river mouth, the channel flows through a Ushaped, unconfined alluvial valley. The channel gradient is 0.03 percent with straight, multiple, and channelized forms with eroded banks. The last 11 miles are within the backwater of the Wells Dam under average flow conditions in the Columbia and Okanogan Rivers.

The Similkameen River, below Enloe Dam, is in a deep, confined, V-shaped valley from river mile 13.8 to river mile 9.2. The lower reach is in a U-shaped, unconfined valley. The channel consists of straight, multiple, and entrenched segments; over half of the segments have eroded banks.

Several lakes in the Upper Similkameen River and Osoyoos Lake on the Okanogan River trap bedload sediment and a portion of the suspended sediment transported from the upper river basins. Channel substrate in the lower river contains a large proportion of fine sediment because of extensive stream bank erosion, erosion from upland farms and ranches, and basinwide masswasting. The riparian habitat of the Okanogan River is the most degraded of the four main Mid-Columbia River tributaries. Lack of riparian vegetation contributes to channel bank instability, sedimentation in the channel, and lack of inchannel pools and cover.

3.1.2.3 Columbia River System

The Columbia Basin is comprised of sedimentary and metamorphic rocks in the north and east, and volcanic and igneous rocks in the west, south, and central parts (USGS 1994). The early geologic history is complex, with terrenes docking against

the ancient North American plate edge in northeast Washington; large and small regions of igneous intrusions; large volcanoes; uplift of the metamorphosed sediments and ocean crust from the edge of the Cascades to the present Pacific coast; volcanic flows across over 100,000 square miles of the Columbia Plateau; great glaciers flowing from the mountains of Canada; extensive valley glaciers; and repeated large glacial outburst floods, draining lakes that covered much of Montana, that flooded the entire Columbia River to the Pacific. The Cascade Mountains grew across the paths of the west-flowing rivers by the late Cenozoic uplift that continues to this day. Only the Columbia and Klamath Rivers were able to erode into the rocks fast enough to continue flowing to the Pacific Ocean.

3.1.3 **S**OILS

Soil types and the parent materials that they formed in are as varied in the Mid-Columbia River region as are the landform and climate zones of the area. Ancient soils have formed in residual materials that have weathered in place over very long periods. Relatively young soils have formed in the materials left by the continental glaciers that covered the northern portions of the Mid-Columbia River region and the alpine glaciers that flowed down the tributary rivers from the Cascade Mountains. The glaciers deposited outwash from rivers flowing off the ice and glacial tills beneath and just in front of the ice. Along the glacially modified valley walls, soils formed in colluvium, materials that accumulate from hillslope erosion. Common to the valley bottoms and along the narrow mountain river terraces are soils formed in alluvium, materials that are deposited by rivers from the glaciers, glaciofluvial deposits, and recent river deposits. Along the river valleys of the Mid-Columbia River and the main tributaries, well-drained soils have formed in deposits of loess, a mixture of wind-blown silt and fine sand derived from till, outwash, and valley bottom river alluvium. Soils have also formed in

volcanic ash deposits and ancient lake bottom sediments.

3.1.3.1 Project Area

Dominant soil types are similar at the Wells, Rocky Reach, and Rock Island Dam sites. They include the Peoh soil series, formed in old alluvium with a surface layer of loess and volcanic ash; and the Cashmont soil series, formed in alluvial and colluvial materials derived from basalt.

The Peoh soils are a gravely, fine, sandy loam with slopes of 3 to 15 percent on the terraces. They have moderately rapid permeability, slow to moderate run-off potential, and a water erosion susceptibility of slight to none.

The Cashmont soils are a sandy loam with slopes of 3 to 8 percent at the edges of the terraces and near the valley walls. They have moderately rapid permeability, slow to medium run-off potential, slight to moderate water erosion susceptibility, and slight to moderate wind erosion potential.

3.1.3.2 Associated Tributaries

Wenatchee River

Most of the soils in the forested mountains of the Wenatchee River Basin are formed in glacial till mixed with volcanic ash and pumice in the surface layers. Some of the upland areas that were not glaciated have residual soils derived from weathered bedrock or wind-blown loess. The most common soils associations are Bjork-Zen and Nard-Stemilt soils (Soil Conservation Service 1973). They are medium-textured, steep to very steep soils underlain by bedrock at 20 to 40 inches depth and are mainly well-drained.

The Bjork-Zen association soils are found on terraces and sideslopes in the hilly uplands. They formed in loess or in material weathered from sandstone or schist with some loess and volcanic ash in the surface layer. They have moderately slow to moderate permeability, and their run-off potential is medium on low-gradient slopes, rapid to very rapid on steep slopes, and rapid on irrigated soils. Their susceptibility to water erosion is moderate on low-gradient slopes, high on steep slopes, and high on irrigated soils. Bjork-Zen soils occur at elevations from 1,000 to 5,000 feet.

The Nard-Stemilt association soils are found on ridgetops, foothills, sides of terraces, and on mountainous uplands. They formed in glacial till, weathered granodiorite, basalt, gneiss, schist, or sandstone bedrock. Their surface layer contains a mixture of loess and some volcanic ash. They have slow to moderate permeability, and their run-off potential is slow to medium on low-gradient slopes, rapid on steep slopes, and rapid on irrigated soils. Their susceptibility to water erosion is slight to moderate on low-gradient slopes, moderate to high on steep slopes, and high on irrigated soils. Nard-Stemilt soils occur at elevations from 1,000 to 5,000 feet.

The valley bottom soils are nearly all alluvial with some being of glacial origin. River channels have nearly level bars of recent coarse sand and gravelly alluvium. The terraces and valley bottoms have Burch-Cashmont and Brief-Leavenworth associations (Soil Conservation Service 1973). Both of these soil associations are primarily medium- to moderately coarse-textured, nearly level to strongly sloping soils on terraces, alluvial fans, bottom lands, and foot slopes. The soils are mainly well-drained. They have moderate to moderately rapid permeability, and their run-off potential is very slow on lowgradient slopes, slow to medium on steep slopes, and rapid on irrigated soils. Their susceptibility to water erosion is none to slight on low-gradient slopes, moderate on steep slopes, and high on irrigated Brief and Cashmont soils.

The Burch-Cashmont association soils are on terraces and low, recent alluvial fans and foot

slopes. The soils formed mainly in valley fill and alluvium, with some loess and volcanic ash in the surface layer. Burch-Cashmont soils occur at elevations from 600 to 1,300 feet.

The Brief-Levenworth association soils are on bottom lands, low terraces, and alluvial fans. They consist mainly of well-drained, moderately coarse- and coarse-textured soils that formed in alluvium but have some loess and volcanic ash in the surface layer. Brief-Levenworth soils occur at elevations from 800 to 2,300 feet.

Mass-wasting, including landslides and debris flows, and surface erosion are the main hillslope processes that transport and deliver sediment to the river channels in the Wenatchee Basin. When located on steep hillsides, the till/volcanic ash mix (common to many of the upland soils) is vulnerable to mass-wasting, erosion, and delivery to the creeks. Areas with extensive logging, road systems, and past grazing in the Mission Creek Basin have accelerated the natural background rates of erosion in the basin. Tractor skidding of logs is still common on private lands and is a significant source of fine sediment to the creeks.

Stream bank erosion and erosion of sediment stored along the stream channels and terraces are the main channel sources of sediment in the stream channels. Bank erosion and transport of channel sediment has been modified in the Wenatchee Basin by altered hydrologic conditions that generate larger and more frequent flood flows; by removal of riparian and stream bank vegetation that modifies the amount of large woody debris, channel structure, and flow velocities; and by rip-rap bank protection, bridge constrictions, dams, and levee structures.

Entiat River

Most of the soils in the forested mountains are formed in glacial till mixed with volcanic ash and pumice in the surface layers. Some of the upland areas that were not glaciated have soils derived from weathered bedrock or loess. The most

common soils are the Entiat-Dinkelman association (Soil Conservation Service 1973). They are predominantly moderately coarsetextured, well-drained, steep to very steep soils underlain by bedrock at a 14- to 60-inch depth.

The Entiat-Dinkelman soils are found on the top and sides of ridges in the foothills and on mountainous uplands. The soils formed in decomposing granodiorite and granite with loess and small amounts of volcanic ash and pumice in the surface layer. They have moderate to moderately rapid permeability, and their run-off potential is slow to rapid on low-gradient slopes, rapid to very rapid on steep slopes, and slight to very rapid on irrigated soils. Their susceptibility to water erosion is none to slight on low-gradient slopes, moderate on steep slopes, and high on irrigated soils. Entiat-Dinkelman soils occur at elevations from 1,000 to 4,000 feet.

The river valley soils are nearly all alluvial, with some being of glacial origin. River channels have nearly level bars of recent coarse sand and gravelly alluvium. The terraces and valley bottoms have Brief-Leavenworth association soils that are the same as described for the Wenatchee Basin valley bottom soils (Soil Conservation Service 1973).

Upland surface erosion from natural and management-related causes has a significant influence on the channel in the lower reaches. Mudflows resulting from high-intensity rainstorms and rain on snow events following extensive fires in the basin are a significant erosion source and cause of siltation in the channel.

Methow River

The upland soils of the Methow watershed are deep to very shallow, mostly grassland soils found on rock outcrop and badlands on dissected upland glacial plains and terraces. Common soil associations include the Newbon-Conconully and

Kartar-Dinkelman-Springdale associations (Soil Conservation Service 1980).

The Newbon-Conconully association soils formed in glacial till on glaciated plains in the basin. They are deep, well-drained soils with a moderate infiltration rate. The dissected glacial plains form undulating and rolling uplands and steep hillsides. In these areas, the association soils are shallow and include rock outcrops. Most of the soils are a gravely loam to gravely, sandy loam. They have moderate to moderately rapid permeability, and their run-off potential is slow to medium on low-gradient slopes and rapid on steep slopes. Their susceptibility to water erosion is slight on low-gradient slopes and high to very high on steep slopes. Newbon-Conconully soils occur at elevations from 1,500 to 3,000 feet.

The Kartar-Dinkelman-Springdale association soils formed in glacial till, outwash, and weathered granite, gneiss, and schist. They are deep, somewhat excessively drained or welldrained soils on glacial plains and terraces. The deeply dissected glacial plains form long, narrow to broad, gently rounded ridges, and long, steep side slopes. The terraces are nearly level and their escarpments strongly sloping. They include sandy loam; gravely, sandy loams; and sandy gravels. They have moderately rapid permeability, and their run-off potential is slow to medium on low-gradient slopes and rapid to very rapid on steep slopes. Water erosion susceptibility is slight to moderate on lowgradient slopes and moderate to very high on steep slopes. The Kartar and Dinkelman soils have moderate wind erosion potential. These soils occur at elevations from 1,500 to 3,500 feet.

The river channels have nearly level bars of recent coarse sand and gravelly alluvium. The terraces and valley bottoms have Owhi-Winthrop association soils upriver of the town of Carlton and Pogue-Cashmont-Cashmere soils downstream. The Owhi-Winthrop association soils formed in glacial outwash and alluvium on terraces. They are deep, well-drained or

excessively drained soils found on nearly level to strongly sloping terraces and terrace escarpments. They have moderately rapid to very rapid permeability, and their run-off potential is very slow to slow on low-gradient slopes and medium to rapid on steep slopes. Their susceptibility to water erosion is none to slight on low-gradient slopes and moderate to high on steep slopes. Owhi-Winthrop soils occur at elevations from 1,400 to 3,000 feet.

The Pogue-Cashmont-Cashmere soils formed in glacial till and outwash on terraces. They are deep, somewhat excessively drained or well-drained soils. They have moderately rapid permeability, and their run-off potential is slow on low-gradient slopes and medium to rapid on steep slopes. Water erosion susceptibility is none to slight on low-gradient slopes and moderate to high on steep slopes. The Cashmont and Cashmere soils have a moderate wind erosion potential. These soils occur at elevations from 700 to 1,050 feet.

Surface erosion is not considered a major issue in the basin, although some local area conditions can be improved.

Okanogan River

The main upland soils of the Okanogan watershed are Rock Outcrop-Nevin-Donavan association, Rock Outcrop-Donavan association, Molson-Lithic Xerochrepts-Koepke association, and Republic-Mires-Chesaw association (Soil Conservation Service 1981). These are deep to very shallow, mostly forest soils and rock outcrops on mountainous uplands.

The Rock Outcrop-Nevin-Donavan association soils formed on mountain uplands and toe slopes in a mantle of volcanic ash and underlying glacial till. The ridges are gently rounded and the hillsides are steep with deep drainages. The soils are well-drained. They have moderate permeability, and their run-off potential is slow to medium on low-gradient slopes and rapid on

steep slopes. Their susceptibility to water erosion is slight to moderate on low-gradient slopes and high to very high on steep slopes. Rock Outcrop-Nevin-Donavan soils occur at elevations from 2,000 to 4,500 feet.

Rock Outcrop-Donavan association soils formed on steep breaks of the deeply dissected glacial plains in volcanic ash over glacial till. Soil properties are similar to the previously described Rock Outcrop-Nevin-Donavan association soils. These soils occur at elevations from 2,000 to 3,500 feet.

Molson-Lithic Xerochrepts-Koepke association soils formed on alluvial fans, outwash terraces, and terrace escarpments in a mantel of volcanic ash, underlying glacial till, and materials weathered from granite. The ridges are gently rounded, and the steep hillsides are cut by deep drainage ways. The soils are well-drained. They have moderate permeability, and their run-off potential is slow to rapid on low-gradient slopes and rapid on steep slopes. Their susceptibility to water erosion is slight to high on low-gradient slopes and high to very high on steep slopes. Molson-Lithic Xerochrepts-Koepke soils occur at elevations from 1,900 to 5,000 feet.

Republic-Mires-Chesaw association soils formed on alluvial fans, outwash terraces, and terrace escarpments in glacial till, reworked glacial till, and outwash. The soils are well-drained to excessively drained. They have dominantly moderate to very rapid permeability, and their run-off potential is slow to rapid on low-gradient slopes and rapid to very rapid on steep slopes. Their susceptibility to water erosion is slight to high on low-gradient slopes and moderate to very high on steep slopes. Republic-Mires-Chesaw soils occur at elevations from 2,800 to 4,500 feet.

On the terraces, ridges, hillsides, and glacial till plains, the common Okanogan Basin soils include the Nighthawk-Conconully-Lithic Xerochrepts and Disanutel-Conconully-Nespelem associations. These are deep to very shallow,

mostly grassland soils, rock outcrop, and badlands on dissected upland plains and terraces.

The Nighthawk-Conconully-Lithic Xerochrepts association soils formed on glacial till plains in glacial till and materials weathered from granite. Most of the association soils are on ridges and hillsides. The ridges are gently rounded and the hillsides are steep. They have moderate to moderately rapid permeability, and their run-off potential is slow to rapid on low-gradient slopes and rapid to very rapid on steep slopes. Their susceptibility to water erosion is slight to high on low-gradient slopes and high to very high on steep slopes. Nighthawk-Conconully-Lithic Xerochrepts soils occur at elevations from 700 to 3,000 feet.

The Disanutel-Conconully-Nespelem association soils formed on plains and terraces in glacial till and lake bottom sediments. The upland plains are undulating and rolling, and the terraces and their escarpments are nearly level and strongly sloping. They have moderately slow to moderately rapid permeability, and their run-off potential is slow on low-gradient slopes and rapid to very rapid on steep slopes. There susceptibility to water erosion is slight on low-gradient slopes and high to very high on steep slopes. Disanutel-Conconully-Nespelem soils occur at elevations from 1,500 to 3,000 feet.

Common soil associations along the valley bottoms of the Okanogan River and tributaries include the Pogue-Cashmont-Cashmere and Colville-Okanogan associations. These are deep, mostly grassland and meadow soils on terraces and floodplains.

The river channels have nearly level bars of recent sand and gravelly sand alluvium. The terraces along the valleys consist of Pogue-Cashmont-Cashmere association soils as described for the Methow Basin valley bottom soils. The Colville-Okanogan association soils are found along the valley bottom floodplains that are subject to flooding. They are deep, somewhat

poorly drained or well-drained soils formed in alluvium. They have moderately slow to moderate permeability, and their run-off potential is very slow. Their susceptibility to water erosion is none to slight. These soils occur at elevations from 700 to 2,000 feet.

Much of the floodplain on the Okanogan is used for crops and winter livestock; during the summer, livestock graze the uplands. Some of the tributaries support year-round ranching. High run-off and erosion rates deliver sediment to ditches and creeks during rainstorms and rapid snowmelt periods.

Surface erosion on bottom lands and masswasting on adjacent hillslopes were serious problems in the 1970s, when clean cultivation and rill irrigation were common in the basin. This erosion source has been reduced somewhat by a switch to alfalfa and seed production and by adoption of Best Management Practices (BMPs).

Degraded riparian vegetation, eroding banks, and sediment delivery to the river channel from upland forest, agricultural, and urban areas contribute to the very poor stream substrate conditions in the Okanogan Basin.

3.1.3.3 Columbia River System

A broad range of soil types has formed in the Columbia River Basin as a result of the wide range of climate zones and the various types and ages of surface geologic materials. The numerous, high mountain alpine regions of the basin contain young soils because of recent alpine glaciers and constant erosion of the surface. They formed in cold climate conditions with seasonal moisture in the spring; brief, warm but dry summer conditions; and dry, cool fall conditions. Much of the Columbia Basin soils formed in dry to moderately dry conditions with cold winters, short moist, spring weather and dry, hot summer, dry, cool fall, and cold winter conditions. From the Mid-Columbia River to the Pacific, the climate varies from dry interior to wet temperate

conditions, changing the way the Columbia gorge and lower Columbia surface materials are weathered into soils compared to the mid- and upper-river basin areas.

The great continental glaciers, and resulting lakes and river flood deposits covered the northern portions and main valley of the Columbia resulting in relatively young soils, less than 9,000 years old. Since the 1880s, extensive dry land

farming and ranching, and since the 1940s, irrigated farming have modified a large portion of the valley bottom, terrace, and foothill soils in the Columbia Basin. During the late 1920s, most of the dry land farms sustained moderate to severe wind erosion of the soils (Social Conservation Service 1973, 1980, 1981). By the mid-1930s, this soil erosion had been reduced as a result of increased rainfall and better cultivation methods.

3.2 FISHERIES RESOURCES

Key Terms

- **Anadromous** Describes the life-history characteristic of a fish species that reproduces in freshwater, migrates to the ocean for some portion of its rearing stage, and returns to freshwater as an adult.
- **Biological Productivity** Capacity of an ecological system to produce or support a particular population size of an animal (fish) or plant species.
- **Broodstock** Group of fish that are used to provide eggs and sperm to produce a hatchery stock to supplement or replace reproduction in a natural environment.
- Critical Habitat Specific areas occupied by a species that contain physical and biological features essential to the conservation of the species, and which may require special management considerations for protection. These areas might provide space for individual or population growth, nutritional or physiological requirements, breeding and rearing habitat, shelter or cover for protection, and/or represent the historical or geographical distribution of the species.
- **Evolutionarily Significant Unit (ESU)** A reproductively isolated animal or fish population that represents an important component in the ecological/genetic diversity evolution of the species. The unit typically has a relatively confined historical or geographical distribution.
- **Juvenile Bypass** Facility that is used to collect, divert or guide juvenile fish around a dam and that provides a safer passage route than through the turbine units.
- PIT-Tag A Passive Integrated Transponder tag (about the size of a grain of rice) transmits a digital code unique to an individual fish when the tagged animal passes through an electromagnetic field of the proper frequency. The tag uses the power emitted by the detection system to transmit the signal, thus it has no batteries (making it functional for years). The tag is typically used on juvenile fish to assess passage survival, as well as survival at the adult stage.
- **Radio-Telemetry** Methodology consisting of attaching or implanting a radio frequency emitting tag in a fish or animal to track its movements or to detect its presence in specific areas. The radio signal emitted by the tag is monitored with a radio receiver and antenna.
- **Resident** Describes the life-history characteristic of a fish species that spends its entire life in freshwater.
- * See Chapter 7 for a complete listing of all Key Terms.

The affected fisheries resources that occur in the project area include anadromous and resident fish species, benthic macroinvertebrates, and aquatic vegetation communities. The anadromous fish species include: chinook salmon, coho salmon, sockeye salmon, steelhead, Pacific lamprey

(Entosphenus tridentatus), and the semianadromous white sturgeon (Acipenser transmontanus). Some 46 other resident fish species also occur in the Mid-Columbia River Basin. The salmonid species found primarily in the tributary or non-mainstem areas include kokanee (landlocked sockeye salmon), bull trout (*Salvelinus confluentus*), rainbow trout (resident form of steelhead), westslope cutthroat trout (*O. clarki lewisi*), mountain whitefish (*Prosopium williamsoni*), and pygmy whitefish (*P. coulteri*). These salmonid species occupy some of the same habitats as the Plan species, and are therefore most likely to be affected by the proposed action.

License articles, amendments, and settlement agreements pertinent to fishery resources are described in Chapter 2 of this EIS. These include project facilities, operations, and hatcheries that were developed to avoid and minimize fish injury or losses as a result of passing through the dams.

3.2.1 <u>THE LISTINGS UNDER THE ENDANGERED</u> <u>SPECIES ACT</u>

On August 18, 1997, the NMFS published notice in the Federal Register, listing the Upper Columbia River Evolutionarily Significant Unit of steelhead as an endangered species under the Endangered Species Act (NMFS 1997). In response to this listing, Chelan and Douglas County PUDs filed interim protection plans with FERC for the Wells, Rocky Reach, and Rock Island Projects. The interim protection plans proposed a program to provide short-term compliance with the Endangered Species Act until the Anadromous Fish Agreements and HCPs could be approved. In accordance with the applications filed by the PUDs, FERC initiated informal consultation with NMFS under Section 7 of the Endangered Species Act. Also included in the consultation is the Upper Columbia River Evolutionarily Significant Unit of spring-run chinook salmon (which was listed as an endangered species on March 24, 1999 [NMFS 1999a]) and the Evolutionarily Significant Unit of Mid-Columbia River steelhead (which was listed as a threatened species on March 25, 1999 [NMFS 1999b]). The consultation for Upper Columbia River spring-run chinook salmon and Upper Columbia River summer-run steelhead was concluded when, in June of 2000, NMFS

issued Douglas County PUD a biological opinion on the proposed interim protection plan for Wells Dam. Although the time frame for the 2000 Wells biological opinion has expired and FERC has provided no indication that it intends to reinitiate consultation, Douglas County PUD has continued to operate the project and implement those actions identified in the 2000 biological opinion. Consultations were not completed for Rock Island and Rocky Reach Projects, and the time frame for the corresponding interim protection plans has also expired.

On February 16, 2000, NMFS published notice of the critical habitat designation for the two endangered species (NMFS 2000c). This designated the major river basins known to support the Evolutionarily Significant Units, including the Wenatchee, Entiat, and Methow Rivers, as well as the Columbia River and estuary for spring-run chinook salmon. These same areas were designated as critical habitat for the steelhead Evolutionarily Significant Unit, as well as the Okanogan River Basin. On April 30, 2002, the U.S. District Court for the District of Columbia approved a NMFS consent decree withdrawing critical habitat designations for 19 Evolutionarily Significant Units (ESUs) of salmon and steelhead (including the three Endangered Species Act-listed species found in the Mid-Columbia River). The critical habitat designations are currently being reevaluated by NMFS.

The Columbia River bull trout populations were also listed as threatened under the Endangered Species Act in June 1998 (USFWS 1998). Because the Mid-Columbia River bull trout populations are not considered anadromous, their protection was not included in the HCPs. However, bull trout are occasionally observed passing through the adult and juvenile passage facilities at the Mid-Columbia River dams. Currently, no biological assessments have been written for bull trout at the projects; however, informal Section 7 consultations between the

PUDs, FERC, and the USFWS have been initiated.

3.2.2 ANADROMOUS FISH RESOURCES

Four species of anadromous Pacific salmonids occur in the Columbia River Basin upstream of Bonneville Dam: chinook, coho (hatchery origin), and sockeye salmon and steelhead. The HCPs apply to all four of these species (Plan species). The incidental take portion of the agreements does not apply to coho salmon, as native populations in the Mid-Columbia River region are now extinct (Nehlsen et al. 1991). However, hatchery coho salmon have been planted in the Mid-Columbia River region in recent years in an attempt to reestablish the runs. The remaining species, which are included in the incidental take portion of the agreements, are referred to as Permit species.

General life-history descriptions and current and historic run size information for these species in the Columbia River system and the Mid-Columbia River reach are provided below.

3.2.2.1 Life History

The timing of adult migration, spawning, incubation, hatching, emergence, juvenile rearing, smolt outmigration, and ocean residence periods differ between species and some of these differences have been used to separate several species into different races/demes. This differentiation is applied to chinook salmon and steelhead because these species exhibit substantial variation in life-history characteristics.

There are three races/demes of chinook salmon in the Columbia River Basin: spring, summer, and fall; and two races of steelhead: summer and winter. These race designations are based on the time that returning adults typically enter the river. However, in recent years the comparison of overall life-history characteristics and genetic assessments has shown that these designations are not always accurate (Chapman et al. 1994a).

A more consistent differentiation scheme, that characterizes the stocks as either ocean-type or stream-type fish, is based on their overall lifehistory characteristics. Ocean-type juveniles migrate to sea as subvearlings, spend most of their ocean life in coastal waters, and return to freshwater as adults, a few months prior to spawning. Stream-type fish migrate to sea as yearlings, exhibit extensive offshore migrations, and return to freshwater many months before spawning (Healey 1991). Within the Columbia River Basin, the production of stream-type fish typically occurs higher in the watersheds than ocean-type fish which typically spawn in mainstem areas and lower tributaries (Waknitz et al. 1995). Mid-Columbia River chinook salmon populations exhibit both types of life-history characteristics.

Mid-Columbia River spring-run chinook salmon enter the lower river in the spring and are categorized as stream-type fish because they typically rear in freshwater for more than 1 year before migrating to the ocean as yearlings. They also tend to spawn in the upper reaches of tributary streams. Although summer/fall-run chinook salmon enter the lower river at different times, and usually spawn in different areas (summer-run chinook salmon tend to spawn higher in the system than fall-run chinook salmon), they both exhibit ocean-type life-history characteristics (spend less than 1 year in freshwater). In addition, there is considerable genetic homogeneity between these two groups. As a result, they are considered part of the same Evolutionarily Significant Unit and are usually called summer/fall-run chinook salmon in the Mid-Columbia River (Waknitz et al. 1995).

For the purposes of the HCPs, summer- and fallrun (ocean-type) chinook salmon are treated as indistinguishable races/demes. However, when spawning is discussed, summer- and fall-run chinook salmon are separately identified and discussed. The fall-run chinook salmon component are defined as those races/demes that spawn in the mainstem Columbia and Snake Rivers, and in the extreme lower reaches of primary tributaries to the mainstem Columbia. The summer-run chinook salmon component are those stocks that do not spawn in the aforementioned areas but do outmigrate as subyearling juveniles (age 0+), the same as fall-run chinook salmon.

Spring-Run Chinook Salmon

The Upper Columbia River Evolutionarily Significant Unit of spring-run chinook salmon was listed as endangered under the Endangered Species Act in March 1999 (NMFS 1999a). These stream-type chinook salmon exhibit substantially more diverse life-history strategies than ocean-type salmonids, probably as a result of differences in the environmental conditions found in the various tributary streams where these fish spend their first year and a half of life. Springrun chinook salmon are found in all of the major watersheds in the Mid-Columbia River except the Okanogan River drainage. Three independent populations of spring-run chinook salmon are identified for the Evolutionarily Significant Unit, including those that spawn in the Wenatchee, Entiat, and Methow Basins (Ford et al. 1999). Adult spring-run chinook salmon return to Mid-Columbia River tributaries from late March through June, after spending 2 to 3 years in the ocean (Chapman et al. 1995a). This species experiences very little ocean harvest.

Chinook salmon passing the Rock Island Dam before June 23 are considered spring-run chinook salmon (Peven 1992). After entering the tributaries, the adults hold in the deeper pools and under cover until the onset of spawning. They may spawn near their holding areas or move upstream into smaller tributaries. Spawning generally occurs from late July through September and typically peaks in late August,

although the peaks vary among tributaries (Chapman et al. 1995a; Peven 1992).

Spring-run chinook salmon eggs hatch in late winter and the fry emerge from the gravel in April and May (Peven 1992). Most of these juveniles rear in freshwater for 1 year before migrating to the ocean, passing the Mid-Columbia River dams between mid-April and mid-June (Mullan 1987). The outmigration of naturally produced spring-run chinook salmon juveniles typically occurs over a longer period than hatchery fish. In addition, naturally produced juveniles are generally smaller than hatchery fish.

Habitat

The extended time spent in freshwater (as adults and juveniles) makes spring-run chinook salmon more susceptible to impacts from habitat alterations than the ocean-type chinook salmon (summer/fall-run chinook salmon). Water withdrawal in some areas has a deleterious effect upon stream-type salmonid spawning distribution, incubation survival, and late summer rearing habitat quality (Chapman et al. 1995a).

Although critical habitat designations for this Evolutionarily Significant Unit are currently being reviewed by NMFS, habitat components important to spring-run chinook salmon and other salmonid species in the Mid-Columbia River include:

- juvenile rearing areas,
- juvenile migration corridors,
- areas for growth and development to adulthood.
- adult migration corridors, and
- spawning habitat.

Within these habitat types, essential features include adequate:

• substrate,

- water quality,
- water quantity,
- water temperature,
- water velocity,
- cover/shelter,
- food,
- riparian vegetation,
- space, and
- safe passage conditions (NMFS 2000c).

Riparian habitat features are also important because they provide shade, sediment transport, nutrient or chemical regulation, stream bank stability, and input (large woody debris or organic matter).

Summer/Fall-Run Chinook Salmon

Most adult summer/fall-run chinook salmon enter the Columbia River from late May to early July and pass the Mid-Columbia River dams from late June through October, after spending 3 or 4 years in the ocean (Peven 1992). Although these two groups of fish are considered part of the same Evolutionarily Significant Unit, and are characterized as ocean-type fish, they spawn in different areas of the basin (Waknitz et al. 1995). Summer-run chinook salmon spawn in the lower portions of the Similkameen River below Enloe Dam, the Okanogan River upstream and downstream of Osovoos Lake, the lower 50 miles of the Methow River, the Wenatchee River downstream of Lake Wenatchee, and in the Lower Chelan River (Chapman et al. 1994b). Spawning typically occurs during late September through November, peaking in October (Peven 1992).

About 70 percent of the Mid-Columbia River fallrun chinook salmon spawning occurs from Vernita Bar (about 4 miles downstream of Priest Rapids Dam) downstream through the Hanford

Reach to the upper reaches of McNary pool (Carlson and Dell 1990). Peak spawning at Vernita Bar occurs in November (Carlson and Dell 1989, 1990, 1991, 1992). Fall-run chinook salmon are also known to spawn in the tailraces of Priest Rapids, Wanapum, Chelan Falls, Wells, and Chief Joseph dams (Chapman et al. 1994a), and possibly below Rocky Reach and Rock Island dams (Dauble et al. 1994). Fall-run chinook salmon spawning also occurs in the Priest Rapids reservoir (Carlson and Dell 1989, 1990, 1991, 1992), Rock Island reservoir (Chelan County PUD 1991), Rocky Reach reservoir (Giorgi 1992; Rensel Associates 2000), and upstream of Wells Dam (Hillman and Miller 1994; Chapman et al. 1994a; Swan et al. 1994; Bickford 1994), where suitable water velocities and substrate conditions occur. However, the extent and magnitude of this spawning activity is unknown.

Juveniles emerge in April and May and move downstream within a few days to a few weeks (Chapman et al. 1994a). Ocean-type fish (summer- and fall-run chinook salmon) generally migrate to the ocean as age-0 subyearlings in late summer and early fall months, passing the Mid-Columbia River dams between June and August (Mullan 1987; Peven 1992; Chapman et al. 1994a). Based on limited snorkel observations. summer-run chinook salmon leave the Wenatchee River in summer as expected for ocean-type fish, but some may rear in the mainstem Columbia River for extended periods (Chapman Consultants 1988). This phenomenon probably occurs on other tributaries to the Mid-Columbia River, and suggests that mainstem reservoirs largely influence the success of ocean-type salmonids.

Habitat

Important habitat components for summer/fall-run chinook salmon are similar to those described above for spring-run chinook salmon, although not necessarily in the same areas or time of year. Summer/fall-run chinook salmon tend to spawn in the mainstem Columbia or lower reaches of tributary streams, and are therefore dependent on

available habitat in those areas for early rearing. Relative to other populations, ocean-type salmonids spend the shortest amount of their life in the tributaries. An important factor that separates this group from others is that juvenile fish have exited the subbasin prior to the lowest flows in fall and are not subject to harsh conditions in winter.

Sockeye Salmon

The life history of sockeye salmon is perhaps the most complex of any Pacific salmon. Although they share the same general life cycle as chinook salmon, other life-history forms of the species are common and play important roles in its long-term survival. Kokanee, a resident form of sockeye salmon, occasionally migrate to sea and return as adults, however there is limited evidence that these fish contribute substantially to sockeye salmon production (NMFS 1994). A third form, known as residual sockeye salmon, often occur together with sockeye salmon. Residuals are believed to be the progeny of sockeye salmon, but are generally non-anadromous themselves.

The distribution of sockeye salmon in the Mid-Columbia River region is limited to the Wenatchee and Osoyoos Lakes, in the Wenatchee and Okanogan watersheds, respectively. Limited numbers of adults and juveniles are periodically detected however, in the Methow and Entiat Rivers (Carie 1996), Icicle Creek, and in isolated areas of the Mid-Columbia River (Chapman et al. 1995b). Despite the considerable mixing of the Wenatchee and Okanogan sockeye salmon stocks during the Grand Coulee Fish Maintenance Project (Fish and Hanavan 1948), the two populations have a high level of genetic distinction in allele frequencies (Winans et al. 1995; Biological Review Team 1996).

The Grand Coulee Fish Maintenance Project (see Section 3.2.4, Hatchery Programs) was a program to preserve the Upper Columbia River anadromous fish runs after the construction of Grand Coulee Dam. The project trapped all adult fish at Rock Island Dam, and transported them to tributary spawning areas for natural production or to hatcheries for artificial production. The hatchery fish were then released into tributary streams downstream of Grand Coulee Dam. This was the beginning of the Leavenworth National Fish Hatchery complex.

Adult sockeye salmon begin entering the Columbia River in May and pass the Mid-Columbia River dams between late May and mid-August (BPA et al. 1994a). Adults reach natural lakes in the Okanogan and Wenatchee watersheds during July through September and spawn during September and October (Mullan 1987; Chapman et al. 1995b). Sockeye salmon fry emerge in March and April and move into freshwater lakes to rear for 1 to 3 years before migrating to the ocean. Sockeye salmon smolts typically pass the Mid-Columbia River dams between mid-April and late May during their outmigration (Chapman et al. 1995b; Columbia Basin Fish and Wildlife Authority 1990).

Habitat

Similar to spring-run chinook salmon and steelhead, sockeye salmon spend substantial time rearing in freshwater areas. They are particularly dependent on the lake environments for juvenile rearing. As a result, these areas represent very important habitat for these fish. They typically rely on mainstem areas as a migratory corridor, although some rearing also occurs during their outmigration.

Steelhead

Although both summer- and winter-run steelhead occur in the Columbia River Basin, winter steelhead typically occur in tributary streams downstream of John Day Dam. Although steelhead exhibit an extremely complex array of life-history characteristics (Peven et al. 1994), NMFS considers all steelhead returning to tributary streams upstream of the confluence of the Yakima River as belonging to the same Evolutionarily Significant Unit (61 Federal

Register, 960730210-6210-01). This Evolutionarily Significant Unit includes steelhead spawning in the Wenatchee, Entiat, Methow, and Okanogan watersheds, and smaller tributaries to the Mid-Columbia River. Only anadromous forms of steelhead are listed due to uncertainties regarding the status of resident forms (rainbow trout), and interactions between the two lifehistory forms. The steelhead produced at the Wells Fish Hatchery are included in the Evolutionarily Significant Unit because NMFS considers them essential to the recovery of natural populations.

Adult steelhead enter the Columbia River during March through October, after spending 1 or 2 years in the ocean. Returning adults typically pass the Mid-Columbia River dams from June through late September. Not only is the adult migration protracted over a long period, spawning does not occur until the following March through July (Columbia Basin Fish and Wildlife Authority 1990; Peven 1992). Unlike other anadromous salmonids, some steelhead adults (kelts) return to the ocean after spawning and may spawn more than once during their lifetime (Peven 1992). However, repeat spawning in the Mid-Columbia River region is typically 2.1 percent or less (Brown 1995).

Steelhead eggs incubate from late March through June, and fry emerge in late spring to August. Fry and smolts disperse downstream in late summer and fall. Their use of tributaries for rearing is variable, depending upon population size, and both weather and flow conditions at any given time. Smolts typically leave the Wenatchee River in March to early June, after spending 1 to 7 years in freshwater, but most leave after 2 to 3 years (Peven et al. 1994). Some steelhead are thought to residualize and live their entire lives in freshwater.

As a result of their varied length of freshwater residence, their variable ocean residence, and their spatial and temporal spawning distribution within a watershed, steelhead exhibit an

extremely complex mosaic of life-history types (Peven et al. 1994). Such life-history diversity is an effective strategy for ensuring the long-term viability of the populations. Steelhead populations in the Mid-Columbia River were depressed by overfishing in the period before the 1950s and continued through the 1970s (Chapman et al. 1994a). However, spawner/recruitment curves constructed by Mullan et al. (1992) indicate that factors outside the tributary watersheds (primarily mainstem passage mortalities) have significant impacts to wild steelhead. Hatchery practices in the past have also contributed to the stock declines. including the practice of planting catchable trout, which have caused an increase in the incidental catch of steelhead (Chapman et al. 1994a).

Habitat

The habitat features important to these streamtype fish are similar to those discussed for springrun chinook salmon (above in Section 3.2.2.1, Life History). However, juvenile steelhead can spend considerably longer periods of time in freshwater rearing as juveniles. As with springrun chinook salmon, the tributary habitat appears to be more important for rearing than the mainstem reservoir areas.

Coho Salmon

Historically, coho salmon were present in both the Columbia and Snake River Basins. Major Columbia River tributaries that supported coho salmon include the Wenatchee, Entiat, and Methow Rivers. Mid-Columbia River coho salmon were decimated in the early 1900s by impassable tributary dams, unscreened irrigation diversions, and extensive harvest. Irrigation, livestock grazing, and mining were major contributors to salmon and steelhead habitat destruction before 1910. Later, timber harvest, fire management, and irrigation impacts were of the most importance. Construction of dams in the tributaries also degraded habitat and blocked access to large portions of the Upper Columbia

River (BPA 1999b). Indigenous coho salmon no longer occur in the Mid-Columbia River region.

Because the historical stocks of coho salmon were decimated near the turn of the century, most life-history information is derived from affidavits from older residents. These accounts support the belief that coho salmon probably returned to the Mid-Columbia River tributaries in September, October, and November. This is also similar to the adult passage timing at the Mid-Columbia River dams in recent years, with the reintroduced stock (Fish Passage Center 2002a). In the Lower Columbia River tributaries, coho salmon spawn from October to mid-December. Juveniles typically spend 1 year in freshwater before outmigrating as yearling smolts in April and May. Coho salmon typically spend about 18 months at sea before returning to spawn (BPA 1999b).

Habitat

The important habitat areas for coho salmon are similar to those discussed for spring-run chinook salmon (above in Section 3.2.2.1, Life History). As with spring-run chinook salmon, the tributary habitat appears to be more important as coho salmon rearing habitat than the mainstem reservoir areas. The mainstem areas function primarily as a migration corridor for coho salmon.

3.2.2.2 Abundance

The best available historical data on the Columbia River salmon runs are the records from the commercial fishing industry. The historical peak catch of Columbia River chinook salmon occurred in 1883, when almost 43,000,000 pounds were taken. This also corresponded to the peak number of canneries operated on the Columbia River (39). At that time, most of the commercial catch consisted of chinook salmon, primarily the high-quality spring-run chinook salmon. Sockeye salmon and steelhead first entered the official catch records in 1889. Large fluctuations in the chinook catch occurred between 1889 and 1920, although the general trend was at a level of about 28,000,000 pounds.

Between 1920 and 1935, the catch declined to a mean of about 18,000,000 pounds (Bell 1937).

Based on commercial harvest data around the turn of the century, spring-run chinook salmon are thought to constitute between 11 and 15 percent of the estimated 3.8 to 4.3 million chinook salmon entering the river (Chapman 1986). However, prior to the extensive commercial harvest in the lower river before the turn of the century, the separation in run-timing between the different races/demes of chinook salmon was believed to have been much less defined and resulted in greater temporal and spatial overlap between the groups (Mullan 1987). Thompson (1951) showed that, historically, Columbia River chinook salmon exhibited a continuous, bellshaped run-timing distribution, entering the river mouth from February through late November, peaking in mid-June.

The fishing regulations before and after the turn of the century resulted in a greater exploitation of the spring- and summer-run fish, and as this portion of the run declined, the fishing seasons were extended to include earlier and later portions of the overall chinook salmon run. Fulton (1968) reports that the spring- and summer-runs dominated the catch until about 1928, when the fall-run catch became larger. This exploitation pattern has resulted in greater separation between the three races of chinook salmon (spring-, summer-, and fall-run) and less mixing between groups on the spawning grounds.

The bell-shaped historical run-timing distribution resulted in some uncertainties regarding the partitioning of the lower river harvest. This has led to considerable confusion regarding the ancestral relationships among chinook salmon populations in the basin (Waknitz et al. 1995).

Spring-Run Chinook Salmon

Counting of spring-run chinook salmon began at Rock Island Dam in 1933, with numbers less than 3,000 fish between 1935 and 1938 (Chapman et

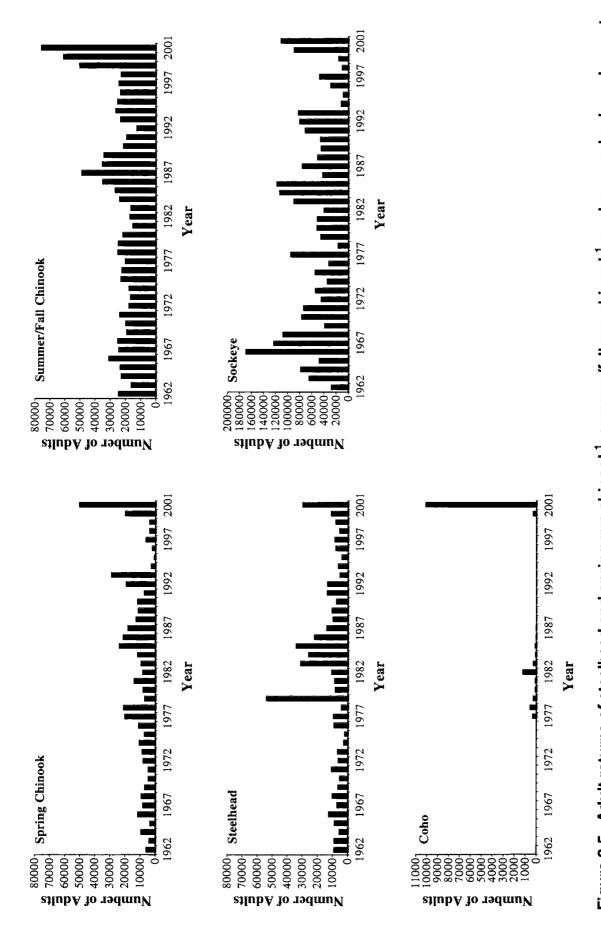


Figure 3-5. Adult returns of steelhead and spring-run chinook¹, summer/fall-run chinook¹, sockeye, and coho salmon at Priest Rapids Dam (1962 to 2001).

Spring- and summer/fall-run chinook salmon numbers represent adult returns from April 16 to June 13, and June 14 to November 15, respectively.

TABLE 3-1. AVERAGE COUNTS OF ANADROMOUS SALMONIDS AT PRIEST RAPIDS DAM (1962 THROUGH 2001), SUMMARIZED BY DECADE

Years	Spring- run Chinook	SUMMER/FALL-RUN CHINOOK	STEELHEAD	Sockeye	Соно
1962 – 1969 ¹	7,698	23,595	8,898	82,809	0
1970 – 1979	10,645	21,389	11,330	53,303	427
1980 – 1989	14,249	27,690	17,758	68,235	234
1990 – 1999	9,043	25,136	8,358	40,750	16
2000 - 2001 ¹	35,616	68,510	20,634	100,434	5,240

¹ Average based on less than 10 years. Source: Fish Passage Center (2002b)

al. 1995a). The average number of spring-run chinook salmon passing Priest Rapids Dam increased about 7,698 to 14,300 fish between the 1960's and 1980's (Table 3-1, Figure 3-5). The average decreased in the 1990's to about 9,000 fish, although the counts in 2000 and 2001 were about 20,000 and 51,000 fish, respectively (Fish Passage Center 2002b).

Summer/Fall-Run Chinook Salmon

Summer/fall-run chinook salmon counts at Rock Island Dam averaged about 5,700 fish (adults and jacks) between 1933 and 1942; they remained less than 9,000 fish until 1951 and ranged between about 12,700 fish and 38,600 fish through 1998 (Chapman et al. 1994b; Fish Passage Center 2002b). At Priest Rapids Dam, the summer/fall-run chinook salmon counts have been relatively steady in each of the decades since that project was completed in 1962 (Fish Passage Center 2002b). The averages observed through the last 4 decades ranged from 21,389 to 27,690 fish. As with the spring-run chinook salmon. however, the summer/fall-run chinook salmon counts were substantially greater in the last 2 years (about 61,100 fish in 2000 and 75,900 fish in 2001).

Steelhead

Between 1933 and 1959, adult steelhead counts at Rock Island Dam ranged from 2,600 to 3,700 fish. In the 1960s, with the beginning of hatchery releases, the Priest Rapids counts ranged from about 6,600 to 13,000 fish (average 8,898 fish) (see Figure 3-5). Similar counts occurred in the 1970s, except for 1979, when the Priest Rapids Dam counts exceeded 54,000 fish (averaging about 11,330 fish). The counts generally increased in the 1980s to between about 8,500 and 34,500 fish, for an average of about 17,758 fish (Chapman et al. 1994b). Although the counts declined to an average of 8,358 fish between 1990 and 1999, substantially higher counts (11,313 and 29,936 fish) were recorded in 2000 and 2001, respectively (Fish Passage Center 2002a).

Sockeye Salmon

Sockeye salmon counts at Rock Island have shown substantial variation since 1933 (ranging between about 950 and 170,100 fish). The counts were generally low between 1933 and 1949, averaging about 25,000 fish (range: 950 to 84,627) (Chapman et al. 1995b). The counts increased to an average of about 99,900 fish in the 1950s (range: 50,100 to 155,800). Counts at

Priest Rapids Dam showed substantial variation between 1962 and 1999, ranging from about 170,100 fish (1966) to 6,700 fish (1994) (Fish Passage Center 2002a). The 1990s had the lowest average count of the 4 decades, ranging from 40,200 to 82,800 fish. As with the other anadromous salmonids returning to the Mid-Columbia River, however, increased escapements were observed in 2000 and 2001 (89,500 and 108,700 fish, respectively).

Coho Salmon

Indigenous natural coho salmon no longer occupy the Mid-Columbia River Basin (BPA 1999b). Coho salmon ladder counts at Rock Island totaled only 475 fish between 1933 and 1943 (Mullan 1984; Mullan et al. 1992). That is an average of less than 48 fish per year, indicating that few coho salmon existed prior to completion of the Grand Coulee and Rock Island dams. After completion of the last Mid-Columbia River mainstem dam (Wells Dam) in 1967, and prior to the recent releases of hatchery coho salmon by the Yakama Indian Nation, peak escapement estimates never exceeded 2,000 coho salmon (Figure 3-5). However, the majority of these returns were likely the result of the hatchery releases. About 46,000,000 fry, fingerlings, and smolts were released from Federal hatcheries between 1942 and 1975 (BPA 1999b). In addition, millions of coho salmon were released from the Chelan County PUD-funded Turtle Rock Hatchery through the mid-1980s. Recently, starting in 1996, the Yakama Tribe has been releasing coho salmon smolts into the Wenatchee and Methow Rivers. Between 1988 and 1999, adult counts at Priest Rapids Dam have averaged only 16 coho salmon, probably a result of strays from Lower Columbia River Hatchery programs and returns from the Yakama hatchery programs.

Self-sustaining populations of coho salmon have not been reestablished in the Mid-Columbia River, despite extensive hatchery plantings. As with other salmonid species, however, coho salmon counts were substantially higher in 2000 and 2001 (1,624 and 10,465 fish, respectively) (Fish Passage Center 2002a).

3.2.2.3 Spawner Distribution

Fulton (1968) reported that spring-run chinook salmon generally spawn in small- and mediumsized tributaries of the Mid-Columbia River, while summer-run chinook salmon generally spawn in intermediate and large tributaries and in the middle reaches of the mainstem. French and Wahle (1960, 1965) observed spring- and summer-run chinook salmon spawning in the same areas of the Wenatchee and Methow Rivers, although summer-run fish were more abundant in the lower reaches and spring-run fish more abundant in the upper reaches of these systems. Fulton (1968) also reported that spring-run chinook salmon typically spawn from late July to late September; summer-run between mid-August and mid-November; and fall-run between September and December.

Spawning distribution in the Mid-Columbia River Basin is somewhat confounded by the fact that spring- and summer-run chinook salmon spawning information was combined in older reports, and summer- and fall-run spawning information was combined in more recent reports. The following distributions (Table 3-2) are based primarily on Fulton (1968) who combined spring- and summer-run chinook salmon.

3.2.3 TRIBUTARY AND MAINSTEM DEVELOPMENT

The congressional authorization of Grand Coulee dam during the early 1930s was the beginning of a period of intense dam construction in the Columbia River Basin. The construction of Grand Coulee Dam in 1934 blocked over 1,000 miles of habitat in the Columbia River Basin to anadromous fish because no adult fishways were built as part of the project (see Figure 1-1 for general location of Columbia River dams).

TABLE 3-2. PRIMARY SPAWNING DISTRIBUTIONS OF ANADROMOUS FISH SPECIES IN THE MID-COLUMBIA RIVER WATERSHEDS

SPECIES	WATERSHED	Tributaries
Spring-run Chino	ok Salmon (Fulton 19	68; Chapman et al. 1995a)
	Wenatchee River	Peshastin, Icicle and Nason Creeks; Chiwawa, Little Wenatchee, Wenatchee, and White Rivers
	Entiat River	Most of mainstem and Mad River
	Methow River	Mainstem Methow River, lower mainstem Twisp River, and Lower Chewuch River
Summer- and Fal	l-run Chinook Salmon	(Fulton 1968; Chapman et al. 1994a; NMFS et al. 1998a; LGL 2001)
	Columbia River	Tailrace of mainstem dams
	Methow River	Lower Mainstem Methow River.
	Okanogan River	Mainstem Similkameen and Okanogan Rivers
	Wenatchee River	Most of the Wenatchee River
Steelhead (Fultor	n 1968; Chapman et al.	. 1994b)
	Wenatchee River	Peshastin, Icicle, and Nason Creeks; Chiwawa, Little Wenatchee, Wenatchee, and White Rivers
	Entiat River	Entiat and Mad Rivers
	Methow River	Methow mainstem; Gold, Libby Wolf, and Early Winters Creeks; Twisp, Chewuch, and Lost Rivers
	Okanogan River	Lower Similkameen River
Sockeye Salmon	(Fulton 1970; Chapma	an et al. 1995b)
	Wenatchee River	Little Wenatchee, Nepeequa, and White Rivers
	Okanogan River	Mainstem Okanogan above Osoyoos Lake

Another 52 miles of habitat were blocked in 1961 with the completion of Chief Joseph Dam. The completion of the Hells Canyon complex in 1961 blocked about 350 miles of mainstem Snake River habitat to anadromous fish. Dworshak Dam is the upstream limit of salmon and steelhead migration on the North Fork of the Clearwater River (BPA et al. 1994a). All mainstem Columbia and Snake River dams downstream of these projects are equipped with facilities to allow passage of adult anadromous fish.

Construction began on the Rock Island Dam in 1929 and was completed before the beginning of the 1932 fish migrations. Fish returning to upstream spawning areas were counted as they passed through the fishladders at the dam. Evaluations showed that sockeye salmon had little difficulty finding and ascending these

ladders, although this was not the case for chinook salmon. Chinook salmon were observed jumping at the dam, and those collected and examined from the fishladders showed about a 20 percent injury rate, most of which were in the head and snout region, apparently due to the fish jumping at the rocks below the dam (Bell 1937).

In addition to the injury rate observed on the chinook salmon adults passing Rock Island, substantial delays in their migration were also apparent. Prior to the completion of Rock Island Dam, the peak catch in the Tribal fisheries at Kettle Falls occurred on about August 1. However, in the years immediately following the completion and operation of the dam, the chinook salmon were delayed 20 to 25 days (Bell 1937). Although the number of fish caught in this fishery also declined after completion of the dam, there is no direct evidence that this was related to passage

problems at the dam. As a result of these apparent deficiencies, a third ladder was constructed prior to the 1936 migration period that provided substantial improvements.

Between 1946 and 1991, the estimated minimum number of upriver spring-run chinook salmon entering the Columbia River followed a generally declining trend, while the number of fish passing Rock Island Dam generally increased. The increasing trend in fish passage at Rock Island is likely due to the curtailment of harvest in the lower river, and the effects of the hatchery programs associated with the Grand Coulee Fish Maintenance Program. In addition to Grand Coulee, Rock Island and Chief Joseph dams, four other mainstem dams were constructed in the Mid-Columbia River between 1959 and 1967. These run-of-the-river projects are: Priest Rapids (1959) and Wanapum (1963) that are owned and operated by Grant County PUD, Rocky Reach (1961), and Wells Dam (1967).

3.2.4 HATCHERY PROGRAMS

The first fish hatchery in the Columbia River Basin was built in 1877 on the Clackamas River, a tributary of the Willamette River in Oregon. This was the first of several hatcheries constructed through the turn of the century to support commercial fisheries, including the Grand Coulee Fish Maintenance Program hatcheries beginning in 1939 and those of the Federal Bureau of Fisheries. A second phase of major hatchery construction occurred in the basin in the 1950s when the Mitchell Act passed in the U.S. Congress in 1938.

Today, there are approximately 90 fish production facilities in the Columbia Basin that support important Indian treaty, sport, and commercial fisheries. The annual catch from Mitchell Act facilities alone averaged 2 million adult anadromous salmonids per year between 1960 and 1985. It is estimated that hatchery fish currently account for 70 percent of spring-run chinook salmon, 80 percent of summer-run

chinook salmon, 50 percent of fall-run chinook salmon, and 70 percent of steelhead returning to the Columbia River Basin (BPA et al. 1994a). In addition, nearly all of the coho salmon returning to the Columbia River are of hatchery origin.

The Grand Coulee Fish Maintenance Program included the first modern hatchery program in the Mid-Columbia River region (Peven 1992). Under this program adult steelhead, chinook, sockeye, and coho salmon were to be trapped in the Rock Island Dam fishways and transferred to a planned hatchery facility on Icicle Creek, a tributary of the Wenatchee River. Fish would be held and spawned at this facility to provide a supply of eggs to substations on the Entiat, Methow, and Okanogan Rivers. However, these hatchery facilities were not constructed before the start of the 1939 anadromous fish runs. Thus, fish trapped at Rock Island Dam were transferred to holding areas established in the three Mid-Columbia River watersheds to allow natural spawning as a means to propagate the stocks.

Holding areas were established in Nason Creek, a tributary of the Wenatchee River, for spring-run chinook salmon and steelhead. The mainstem Wenatchee and Entiat River holding areas were used to propagate summer- and fall-run chinook salmon and steelhead, and Lake Wenatchee and Osoyoos Lake were used to propagate sockeye salmon. The original success of this natural spawning program led to the inclusion of a natural spawning component in the Grand Coulee Fish Maintenance Program in subsequent years. The Leavenworth National Fish Hatchery and satellite facilities were completed and operational in 1940 to continue the Grand Coulee Fish Maintenance Program. The trapping program at Rock Island Dam ended in late fall 1943, while the hatchery component of the Grand Coulee Fish Maintenance Program continues to the present day.

The Leavenworth National Fish Hatchery on Icicle Creek was completed and operational in 1940. Over the years, varying numbers of eyed

eggs were shipped from this facility to the Entiat and Winthrop substations for hatching, rearing, and release. Fingerlings were also released directly into the Wenatchee system from the Leavenworth Hatchery. The Grand Coulee Fish Maintenance Program used all adult anadromous salmonids captured at Rock Island Dam between the years 1939 and 1943, after which, portions of the adult runs were allowed to pass Rock Island to migrate and spawn naturally.

The Grand Coulee Fish Maintenance Program had a profound impact on the genetic integrity of the various native fish runs in the Mid-Columbia River region. The mixing of stocks, as a result of this program, eliminated the genetic uniqueness of the individual Mid-Columbia River runs and produced homogenized stocks that were used in subsequent years to seed the entire region. Exacerbation of these impacts occurred in subsequent years with the extensive mixing of hatchery progeny with progeny from wild spawning adults, and the inclusion of non-native broodstock in the hatcheries.

Despite the extensive introduction of hatchery fish in the Columbia River, the proportion of hatchery fish that spawn naturally is generally low, although it varies by species and spawning location. Murdoch and Petersen (2000) estimated that hatchery summer-run chinook salmon escapements to the Wenatchee River varied between 2 and 12 percent in 1991 through 1998. Hatchery escapements to the Methow and Okanogan Rivers ranged from 0 to 45 percent, and 0 to 59 percent, respectively. Hatchery contributions of fall-run chinook salmon in the area are estimated to be between 20 and 30 percent. While there is little evidence that Mid-Columbia River hatchery spring-run chinook salmon stray to natural spawning areas within the Wenatchee River, the steelhead spawning escapements are dominated by hatchery-produced fish (NMFS 2000c).

3.2.4.1 Hatchery Compensation for Mid-Columbia Habitat Inundation

Further expansion of the Mid-Columbia River hatchery system occurred between 1961 and 1967, with the construction of four hatchery facilities as compensation for lost fish production from inundation of the mainstem Columbia River by Priest Rapids, Wanapum, Rocky Reach, and Wells dams. The Priest Rapids, Turtle Rock, and Wells hatchery facilities were originally designed as spawning channels to allow natural spawning activity. However, the limited success of these channels led to the construction of conventional fish production hatcheries in the early 1970s. The fourth mainstem compensation facility, the Chelan Hatchery, is also a conventional hatchery.

3.2.4.2 Hatchery Compensation for Mid-Columbia Mainstem Passage Losses

The third phase in the development of the Mid-Columbia River hatchery program began in 1989 with the construction of several facilities to enhance tributary production. These facilities include the Eastbank Hatchery and five satellite locations. In 1992, the Methow Hatchery and two satellite acclimation ponds were completed as well as the experimental facilities at the Cassimer Bar Hatchery. These facilities were the result of long-term settlement agreements for the Wells and Rock Island Projects to compensate for ongoing fish passage losses at the projects. With the exception of the Cassimer Bar facility, which is operated by the Colville Tribe, the PUD hatchery facilities are operated by WDFW.

3.2.4.3 Current Hatchery Production

Between 1980 and 1998, summer-run chinook salmon releases in the Mid-Columbia River region averaged about 2.22 million fish and ranged between 0.27 and 3.89 million fish. Spring-run chinook salmon releases ranged

between 1.33 and 6.46 million fish, and averaged about 4.59 million fish for these same years. An average of about 1.46 million juvenile steelhead were also released in the Methow, Entiat, and Wenatchee River systems, as well in the mainstem Columbia River between 1980 and 1998.

Hatchery releases in 1998 included about 340,000 coho salmon in the Methow River, about 285,000 yearling sockeye salmon from net pens in Lake Wenatchee in 1998, and about 80,500 subyearling sockeye salmon near the mouth of the Okanogan River (Table 3-3).

However, after 9 years of funding the experimental Cassimer Bar Sockeye Hatchery

program, the program was eliminated in 2001 because it failed to produce meaningful numbers of adult returns. As a result, the mitigation for unavoidable sockeye salmon losses at Wells Dam will consist of rearing an additional 225,000 spring-run chinook salmon smolts through spring 2005, and through the Okanogan Flow Management Plan after 2005 (Douglas County PUD et al. 2002). This plan is currently being implemented by the Canadian Fisheries Agencies and Tribes. These groups estimate that the flow management plan should result in a 15 percent increase in the production of Osoyoos Lake sockeye.

TABLE 3-3. HATCHERY FACILITIES OWNED OR FUNDED BY THE MID-COLUMBIA RIVER PUDS IN COMPENSATION FOR PROJECT IMPACTS TO ANADROMOUS FISH SPECIES

COMPENSATION OBJECTIVE/FACILITY	OPERATOR	YEAR	Species	Production Levels
Assumed 14% Wells Project Mortality	,			
Cassimer Bar Hatchery	Colville Tribe	1992	Sockeye	200,000 ¹
Osoyoos Lake Net Pens		1993	Sockeye	200,000 ¹
Wells Hatchery	WDFW	1992	Summer-run steelhead	180,000
Methow Hatchery	WDFW	1992	Spring-run chinook	250,000
Chewuch Pond		1992	Spring-run chinook	250,000
Twisp Pond		1992	Spring-run chinook	250,000
Original Wells Pool Inundation				
Wells Hatchery	WDFW	1967	Summer-run chinook	800,000
			Summer-run steelhead	300,000
Original Rocky Reach Pool Inundation	n			
Chelan and Turtle Rock Facilities	WDFW	1995	Summer-run steelhead	200,000
Rocky Reach Hatchery and	WDFW	1969	Summer-run chinook	1,600,000
Turtle Rock Pond (combined)			Fall-run chinook	200,000
Ongoing Rock Island Inundation/Proj	ect Mortality			
Eastbank Hatchery	WDFW	1989	Summer-run steelhead	200,000
Carlton Pond		1989	Summer-run chinook	400,000
Dryden Pond		1989	Summer-run chinook	864,000
Similkameen Pond		1989	Summer-run chinook	576,000
Chiwawa Pond		1989	Spring-run chinook	672,000
Lake Wenatchee Net Pens		1989	Sockeye	200,000

¹ This was an experimental program. No sockeye broodstock were collected after 2000 because this artificial production program is being phased out.

3.2.4.4 Interaction Between Hatchery Stocks and Wild Stocks

Hatchery fish can directly impact wild stocks through increased competition, disease transmission, and loss of distinct genetic characteristics. They can also have indirect impacts by increasing the susceptibility of wild stocks to predation.

Competition

Competition for food and space between hatchery and wild juvenile salmonids is greatest at hatchery release sites, where small numbers of wild fish must compete for available resources with large numbers of hatchery fish. Although, this competition at the release site is expected to diminish as hatchery fish disperse, the initial competition might force wild fish from preferred habitats and increase their susceptibility to predation (BPA et al. 1994c).

Disease

Pathogens that cause disease in salmon and steelhead are present in both wild/natural and hatchery populations, although the hatchery environment encourages the spread of pathogens due to relatively high fish densities. However, there is little information on the impacts of infectious diseases on natural production, and no direct evidence of increased incidence or prevalence of disease in wild/natural populations downstream of hatcheries. Although horizontal (fish to fish) transmission of some pathogens might occur when diseased and healthy fish are held in close proximity, there is little information that suggests similar transmissions in the free-flowing river environment (BPA et al. 1994c).

Genetics

Hatchery management activities can affect the genetic integrity of wild/natural populations in several ways. The release of large numbers of

hatchery fish tends to increase the hatchery component in the total adult population. Subsequent harvest regulations based on a proportion of the total run can result in greater impacts to wild/natural fish populations than the hatchery stock. Large hatchery populations can withstand higher harvest levels than a small natural population because it takes fewer adult spawners to fully stock a hatchery program compared to a natural system where natural mortality rates are substantially greater. Selective hatchery breeding protocols, the straying of hatchery fish to natural spawning areas, and the use of non-indigenous hatchery stocks tend to deplete the native genetic characteristics of the wild population (BPA et al. 1994c).

The use of natural broodstocks can also reduce the number of natural spawners. Early broodstock collections in the Columbia River Basin may have led to depletion of wild races/demes. Recent broodstock collection activities have been modified to lower the risk of depleting wild donor races/demes. However, captive-broodstock programs are currently being implemented to reestablish natural populations without needing to remove natural spawners from the system each year. The advantage of including a natural broodstock component to a hatchery program or establishing a captive-broodstock program is that they increase the number of returning adults, without overwhelming or replacing the natural gene pool.

Inadvertent artificial selection (domestication) can occur from a variety of hatchery practices that cause nonrandom mortality and selection, and where rearing and release strategies differ substantially from natural life-history patterns. Inadvertent selection can be avoided through implementation of strict mating and fertilization protocols, and by ensuring that hatchery fish are, qualitatively, as similar to naturally produced fish as possible (BPA et al. 1994a).

A number of hatchery practices can lead to loss of within-population variability. Broodstock

selected for particular traits can lead to loss of traits that may have benefit to the wild gene pool. Examples of this include marked shifts in population run timing over several generations when broodstock is selected from one segment of the natural run cycle (Steward and Bjornn 1990). Loss of within-population variability can also occur where a disproportionate ratio of males are mated to females or the mating population is small. Current hatchery practices minimize these types of selections.

Loss of between-population variability can occur when broodstock is collected from locations that are remote to the targeted watersheds. In the past, non-indigenous stocks and hatchery-derived stocks were commonly mixed. For genetic and fish health reasons, that practice has been discontinued and race/deme transfers are limited. Crossing of unrelated races/demes can also occur with high straying rates of hatchery fish into non-targeted streams (BPA et al. 1994c).

The majority of the above mentioned concerns regarding anadromous salmonid production operations are common to hatcheries throughout the Pacific Northwest. Significant improvements in hatchery practices have been instituted in PUD-funded facilities. On-going efforts by the State and PUDs also strive to minimize the deleterious effects of hatchery practices on wild populations and yet ensure a harvestable surplus of anadromous salmonids.

Predation

There is little available data to quantify direct predation of hatchery fish on wild fish, although as the size difference between hatchery and smaller wild fish increases, the predation potential is expected to increase. Salmonid predators are generally thought to prey on fish approximately one-third or less of their length (BPA et al. 1994c). Therefore, the predation of wild fish is expected to be greatest at the fry stage compared to smolts (USFWS 1994). This suggests that the greatest predation potential is expected to be from

resident fish on the small wild fish that are displaced or drawn out of their natural rearing areas by the behavior and interactions with hatchery fish.

The large number of hatchery fish in the system tends to support a correspondingly large population of predators. These predators are attracted to fish bypass outfalls or dam tailraces, where juvenile fish are more concentrated, and the resident predators might prey more heavily on the smaller wild fish (USFWS 1994).

3.2.5 Adult Survival at Projects

3.2.5.1 Upstream Migration of Adults

Prior to dam construction, upstream migrating fish encountered rapids, chutes, and falls which were common in the Mid-Columbia River reach. The mainstem projects replaced the numerous natural gradient breaks with larger gradient breaks (i.e., the dams), interspersed with large pools (i.e., reservoirs). To pass fish over the dams, fishways were built at these dams. Although most salmon and steelhead successfully pass upstream over the projects, the PUDs continue to modify adult passage facilities to improve upstream passage conditions. Other fish species (e.g., sturgeon) do not pass through the fishladders as effectively (Hanson et al. 1992; BPA et al. 1994c).

Dam Passage

Three specific components of the adult migrations through the Mid-Columbia River corridor may affect anadromous fish species: delay at project fishways, passage success at project structures, and injuries and mortalities resulting from upstream and downstream passage through project facilities. Each of these components has the potential to increase pre-spawning mortality. For fish that do reach spawning areas, indirect effects associated with passage through multiple dams may reduce fecundity and reproductive

success. Unfortunately, the relationship between each of these passage measures and reproductive success is not clearly understood.

Adult salmon and steelhead pass upstream through the Mid-Columbia River PUD dams via fishways installed at the projects. The fishways typically consist of an entrance gallery and ladder, a diffuser system that provides additional water at the ladder entrances (to attract fish from the tailrace), and a flow control section at the ladder exit that maintains ladder flow over varying forebay elevations. Observation areas have been established in each ladder to monitor upstream progress and the Wells and Priest Rapids dams have ladder traps for broodstock collection and stock assessment purposes. Migrational delays are most likely to occur at fishladder entrances, in the collection galleries, and during operation of the traps. Injury related to fish passage facilities is usually minimal; however, system failures (especially at diffuser gratings in the entrance pools) can result in injury and mortality.

Assessments of the magnitude and effects of migratory delays at fishway facilities is complicated by the lack of information on the time required for adult anadromous fish to migrate through the unimpounded, natural reaches of the Mid-Columbia River. In addition, there are other environmental factors that influence migration in the Mid-Columbia River including hydrology, water temperature (in mainstem and tributaries), dissolved gas supersaturation, and turbidity (Dauble and Mueller 1993).

Of these environmental factors, water temperature undoubtedly has the greatest influence of upstream migration. However, the Mid-Columbia River projects have limited influence on water temperature. Project operations also have little influence on turbidity. However, spilling operations directly affect total dissolved gas saturation levels downstream of the projects. Backman and Evans (2002) found a very low

incidence of gas bubble trauma (less than 1 percent) in adult steelhead and chinook and sockeye salmon, despite sampling large numbers of fish from water exceeding 120 percent total dissolved gas saturation. Ecology grants a water quality standard waiver in the spring and summer on the Columbia River (allowing up to 120 percent total dissolved gas saturation in the hydroelectric project tailraces) to allow spill levels that will aid downstream migrating juvenile salmonids. In addition, there is no information that adult fish react to changes in total dissolved gas levels. Project operations (such as turbine and spill schedules) may also directly affect passage at these mainstem dams by increasing or decreasing the attraction of adults to the ladder entrances.

The impacts of delay vary by species, race/deme, and according to hydrologic and water quality conditions. Species such as spring-run (streamtype) chinook salmon, summer-run (ocean-type) chinook salmon and steelhead that hold in the river for considerable periods prior to spawning are less likely to be negatively affected by slight to moderate delays at fishways (Meekin 1969). Late migrating species such as fall-run (oceantype) chinook salmon have a much shorter migratory "window" and may be more susceptible to the effects of delayed migration on pre-spawning mortality or spawning success (Meekin 1969).

Adult migration and passage rates, as well as tributary escapement estimates, have historically been evaluated by comparing fish counts at each of the Columbia River dam fishladders.

Similarly, pre-spawn mortality rates were estimated by comparing spawning ground survey data with the estimated escapements. More recently, this information has been supplemented with radio-telemetry studies. However, these methods only provide information on how well radio-tagged fish pass from the tailrace of a specific dam into and through the fishway and beyond. The underlying assumption is that the behavior of radio-tagged fish is generally similar

to untagged fish. Laboratory assessments of tagged and untagged fish and several years of field evaluations support this assumption, although little information is available regarding tagging effects on migrating fish in a riverine environment, or their reproductive success.

Radio-tagging studies are often unable to account for all the tagged fish, so their ultimate fate cannot always be determined.

Although there is no direct relationship between project passage times and reproductive success, reducing passage time is generally believed to reduce energy expenditures and improve the likelihood of adult fish surviving to spawn. Over the entire adult freshwater migration phase, passage time at each of the projects is typically slower than in an unobstructed river reach. However, passage time through the reservoirs is typically faster, and energy expenditures are less than for fish migrating through a normal river setting. The median migration rate through the Mid-Columbia River (Priest Rapids tailrace to Wells forebay) was 12.5 miles/day, which exceeds the rates observed in free-flowing reaches of the Skeena River (7.9 to 11.1 miles/day) and the Fraser River (5.3 miles/day) (English et al. 2001).

Issues currently identified for adult salmon and steelhead that may affect injury and delay include entrance into the fishladders from the tailrace, passage in the junction pool between the fishway entrances and the ladder, large tailwater fluctuations that impact fishway operations, and fallback. Although the delay at one dam may not be significant, the cumulative delays (should they exist) at the nine passable dams on the Columbia River may decrease spawning success. However, due to various factors (such as unknown losses caused by fisheries, tag loss or failure, fallback and tributary turnoff, and natural mortality rates) it is difficult to use the results of adult radio telemetry studies to estimate project specific mortality.

The radio-telemetry evaluations can provide valuable information about specific areas within the fish collection and passage facility that appear to causing passage delays. However, only limited information can be obtained from fish that do not enter the system. Although the time it takes for fish to locate and enter the facilities can be quantified, it is extremely difficult to determine the causes of the delays. The delays may be the result of poorly designed passage facilities or factors related to either the operation of the passage facilities or the project as a whole. In addition, fish that fail to pass a dam may be destined for a downstream spawning location or hatchery, or may have been affected by passage at downstream dams. The effects of the tagging process, as well as tag losses, can also affect the apparent conclusions of passage evaluations or the connection to reproductive success. The information can be used however, to assess the success of adult migrating upstream through the project area and to develop an index that can be used to assess improvements in passage conditions.

Stuehrenberg et al. (1995) conducted a Mid-Columbia River evaluation that attempted to track radio-tagged chinook salmon from the Priest Rapids Dam tailrace to their spawning grounds or hatcheries. In that study, the researchers estimated that the minimum survival rate of spring-run chinook salmon from Priest Rapids Dam to the spawning grounds (or hatcheries) was 77.8 percent. If all of the spring-run chinook salmon with unknown fates detected downstream of Priest Rapids Dam (N = 38) were fish from the Ringold Facility (i.e., not destined for areas upstream of Priest Rapids Dam), the survival estimate would increase to 88.9 percent. A similar evaluation in 1999 with radio-tagged steelhead indicated that 81 percent of the fish released downstream of Priest Rapids Dam were tracked to tributary spawning areas (English et al. 2001).

Chapman et al. (1994a,b, 1995a) assumed average total mortality rates for all the Mid-

Columbia River adult summer/fall-run chinook salmon at 5 percent, 4 percent for adult steelhead, and 2 to 6 percent for adult spring-run chinook salmon. NMFS (1998a) assessed various radiotelemetry studies and concluded that the average per-project mortality rates for Upper Columbia River adult spring-run chinook salmon and adult steelhead passing the four Lower Columbia River dams were 3.0 and 1.2 percent, respectively. NMFS again assessed the available information in 2000 and estimated that per project mortality rates for spring-run chinook salmon and steelhead were 2.4 and 3.2 percent, respectively (NMFS 2000a). In 2002, NMFS conducted preliminary analysis of PIT-tag information to corroborate radio telemetry study estimates. This analysis confirmed that in 2001, a year characterized by very low flows in both the Snake and Columbia Rivers and substantially reduced or eliminated juvenile spill programs at the Federal projects, the estimated per project survival of adult Snake River spring-run chinook salmon was approximately 99 percent (NMFS 2002d). Adult fishways at the PUD-owned Mid-Columbia hydroelectric projects and the Federally owned Lower Columbia River projects are of similar design, and operated in a similar manner. For these reasons, the mortality estimates derived from the Lower Columbia River projects should be generally applicable to the Mid-Columbia River projects.

At present, it is not possible to differentiate between hydrosystem caused mortality and natural mortality (which undoubtedly occurs) with the technologies available. Per-project mortality estimates based on available information include both sources. Therefore, mortality rates attributable to the effects of hydroelectric projects are undoubtedly lower than those presented, but to an unknown extent.

Wells Dam

The median project passage time for adult spring-, summer-, and fall-run chinook salmon at the Wells Dam was 28.5, 46.9, and 45.7 hours, respectively, during a 1993 evaluation

(Stuehrenberg et al. 1995). This study also noted that fish successfully passing the project moved directly into the collection channel from the tailrace with minimal delay. As a result, the majority of the passage delay was associated with the collection channel itself. Of the 28.5 hour median project passage time for spring-run chinook salmon, over 90 percent, or 26.8 hours was spent attempting to negotiate the collection channel.

Modifications to project operations and fish ladder trapping protocols, to reduce the apparent adult fish passage problems at Wells Dam, were successfully tested in 1997, 1998 and 1999 and implemented in 2000 following agreement of the Wells Coordinating Committee.

In 1997, median passage times from the Wells Dam tailrace to the fish ladder exits for summerrun chinook salmon, steelhead, and sockeye salmon were about 41, 10, and 21 hours, respectively (Alexander et al. 1998). Nass et al. (2000) reported an average passage time of 39 hours for summer-run chinook salmon in 1998. Similar project passage rates have been observed at other Mid-Columbia, Lower Columbia, and Snake River dams (see Table 2-4). However, Swan et al. (1994) reported a substantially faster passage rate for sockeye salmon at Wells Dam (5 hours).

Median passage time for steelhead was about 17 hours in 1999, even through the east and west fishladder traps were operated throughout most of the monitoring period. English et al. (2001) report that adult steelhead passage rates were 2 to 5 times longer when the Wells Dam ladder traps are operated than during non-trapping periods.

These studies also estimated fallback rates at Wells Dam (see Table 2-4). The 1993 telemetry evaluation estimated a 3.6 percent (2 of 56 fish) fallback rate at Wells Dam for spring-run chinook salmon. However, both of these fish were later detected in the Entiat River, suggesting that they may have inadvertently passed the project

originally and the apparent fallback was a voluntary action. Summer-run chinook salmon fallback rate surpassed 15 percent in 1997 and 1998 (English et al. 1998b; Nass et al. 2000), although the location of the summer-run chinook salmon hatchery and the known summer/fall-run chinook salmon spawning areas downstream of Wells Dam suggest that most of the apparent fallback was voluntary. Sockeye salmon fallback was estimated at 3.5 percent in 1997, although 63 percent of these fish reascended the dam and were tracked to spawning grounds (English et al. 1998b).

Alexander et al. (1998) also provided information on steelhead. Of the 20 radio-tagged steelhead that were detected at the Wells Dam, 16 fish (80 percent) successfully passed and remained above the dam during the study period. Of the 4 fish last located below the dam, 2 fish were last detected in the broodstock held at the Wells Hatchery and 2 fish were last detected at the Wells Hatchery outfall. A more extensive study in 1999 found that 162 of 174 steelhead (93 percent) detected at the dam passed upstream of the project (Alexander et al. 2001).

Alexander et al. (1998) reported that, for steelhead successfully negotiating the dam, the median project passage time was about 10 hours. Once upstream of the dam, the median migration rate to the Methow River 15.8 miles per day but only 4.5 miles per day to the Okanogan River.

Alexander et al. (1998) reported 1 of 20 steelhead (5 percent) fell back below Wells Dam, and English et al. (2001) reported a 6.8 percent fallback rate for steelhead at Wells Dam in 1999. Of the 11 fish that fell back, 4 reascended the ladder, 6 were found in spawning areas downstream of Wells Dam with only 1 fish classified as an involuntary fall back.

These fallback rates are consistent with the other Mid-Columbia River dams (range: 7 to 12 percent). English et al. (2001) also found that 94 percent of the fallback fish were of hatchery

origin. In addition, 70 percent of the hatchery fish and 100 percent of the wild steelhead that passed the dam were last detected either upstream of the dam or at known spawning areas. Most of the hatchery fish that remained below Wells Dam overwintering in the Wells Hatchery outfall.

English et al. (2001) estimated a 34 to 69 percent range in kelting rate for the Mid-Columbia River steelhead stocks, although the survival rates were not assessed. Although direct information is not available, it is reasonable to assume that adult survival during fallback and kelt (post-spawning steelhead) passage is much higher passing through the juvenile bypass system than through turbines.

Rocky Reach Dam

Median project passage times at the Rocky Reach Dam were estimated at about 37 hours for adult spring-run chinook salmon, 23 hours for summerrun chinook salmon, and 60 hours for fall-run chinook salmon (Stuehrenberg et al. 1995) (see Table 2-4). English et al. (1998c) estimated a median passage time of 26 hours for the 22 radiotagged steelhead that successfully passed the project in 1997. However, the evaluation of 229 steelhead passing Rocky Reach Dam in 1999 indicated a substantially faster median passage time (about 13 hours) (English et al. 2001). The overall range of these median passage times encompasses those recorded for sockeye and summer-run chinook salmon (36 and 30 hours, respectively), which were based on between 103 and 249 fish detected at Rocky Reach (English et al. 1998c). The observed adult fish passage times at Rocky Reach are similar to those at other Mid-Columbia River dams (see Table 2-4). English et al. (2001) report a fallback rate of about 10 percent for steelhead in 1999, although 95 percent of these fish were of hatchery origin. As a result, they estimated that only 1 percent of the radiotagged steelhead that passed Rocky Reach Dam fell back involuntarily.

English et al. (1998c) observed fallback rates for summer-run chinook and sockeye salmon of 2

and 14 percent, respectively. It is unclear if the fish fell back through the powerhouse or over the spillway. Spill at the Rocky Reach Dam was higher in 1997 than during the 1993 radiotelemetry evaluation, but the number of summerrun chinook salmon that fell back over the dam were comparable between years.

As discussed above, the various uncertainties related to radio-telemetry data make it difficult to estimate project-specific mortality. The level of uncertainty associated with these data is substantial; documented fallback, delay, and unaccounted loss below the project indicates that adult passage problems may be occurring at Rocky Reach Dam. It is also not possible to differentiate natural effects from system-related effects at this time.

Approximately 236 steelhead kelts were observed in the juvenile bypass system in 1998. Although direct information is not available, it is reasonable to assume that adult survival during fallback and kelt passage is higher passing through the juvenile bypass system than through turbines. Although the bypass is not specifically operated throughout the entire adult and kelt passage seasons, it provides some protection to these fish when it is operated. Adult passage through the spillway is also assumed to be safer than turbine passage.

Rock Island Dam

Median project passage times at the Rock Island Dam were 20 hours for adult spring-run chinook salmon, 15 hours for summer-run chinook salmon, and 19 hours for fall-run chinook salmon in radio-telemetry evaluations conducted in 1993 (Stuehrenberg et al. 1995). Median passage times observed in 1997 were 17 hours for sockeye salmon, 15 hours for summer-run chinook salmon, 39 hours for spring-run chinook salmon, and 4 hours for steelhead (English et al. 1998c). However, some of the 1997 results were based on very small sample sizes. Of the 680 spring-run and 975 steelhead tagged at the Bonneville Dam in 1997, only 12 and 25 were detected at the Rock Island Dam, respectively. During the 1999

steelhead study, fish were tagged at Priest Rapids Dam. Of the 398 fish radio-tagged steelhead released, 309 were detected at Rock Island Dam in 1999. The median passage time for these fish was about 4 hours.

The sample sizes obtained in 1997 for sockeye and summer-run chinook salmon were large enough to identify potential problem areas in the adult fishways. Although the data are not absolutely clear, delay locating the fishway entrances and delays at the junction pool areas below the ladders account for the largest percentage of the passage times. Median passage times for summer-run chinook and sockeye salmon in 1997 were 15 and 17 hours, respectively (see Table 2-4).

English et al. (1998c) noted that no spring-run chinook salmon, 3 summer-run chinook salmon (2 percent), 12 sockeye salmon (4 percent) and 1 steelhead (4 percent) fell back over the Rock Island Dam in 1997 (see Table 2-4). It is unclear if the fish fell back through the powerhouse or over the spillway, although spill was occurring at the time.

English et al. (2001) reported about a 7 percent fallback rate for steelhead in 1999, although 86 percent of these were hatchery fish. More than twice as many of these fallback fish (59 percent) originally passed the project through the rightbank fishladder, compared to 18 and 23 percent through the left-bank and center fishways, respectively. The authors estimate that less than 2 percent of the radio-tagged steelhead that passed Rock Island Dam fell back involuntarily.

As noted above, because of uncertainties with the radio-tagging study results, it is not possible to accurately determine mortality rates, nor is it possible to differentiate natural effects from project effects.

3.2.6 JUVENILE SURVIVAL AT THE PROJECTS

Dam structures form a physical barrier in the path of fish migrating downstream. Mechanisms that allow fish to pass from the upstream to the downstream side of any dam are:

- passage through a turbine;
- passage over a spillway or through a sluiceway;
- passage through a juvenile bypass system;
- passage in a downstream direction through ancillary dam facilities, such as the adult fishway facilities; or
- collection of fish on the upstream side of the structure followed by transport and release on the downstream side.

Potential impacts resulting from any project passage route can be categorized as either a direct or indirect effect. Direct effects are a consequence of physical injuries that may be incurred during passage through spillway, sluiceway, or turbine structures. Direct effects may result in immediate or delayed mortality (Chapman et al. 1994a). Indirect effects result from debilitated, disoriented, or stunned juvenile fish being exposed to additional sources of mortality such as predation (Chapman et al. 1994a).

Over the last decade or more, substantial effort has been directed at improving juvenile fish passage conditions throughout the basin as a response to declining anadromous fish populations. NMFS (2000d) reports that during the 1960s, direct survival of yearling migrants through the entire Federal hydropower system (Lower Snake and Columbia Rivers) was 32 to 56 percent. This represents a period before the four Lower Snake River projects were built (1968 to 1975). Estimates of survival during the 1970s declined to a typical range of 10 to 30 percent, and less than 3 percent for the 1973 and 1977 drought years. However, between 1995 and

1999, survival of yearling Snake River spring/summer-run chinook salmon ranged between 42 and 59 percent. These recent survival improvements are substantially higher than during the 1970s and are believed to be similar to those estimated for the 1960s. These improvements are likely the result of good flow conditions, the implementation of project operation and fish passage improvements, and substantial reductions in predator fish populations. Despite these survival improvements, salmonid populations throughout the basin continued to decline or remained relatively flat until the last few years (see Section 3.2.2.2, Abundance). The increases observed in recent years are believed to be due primarily to improved ocean rearing conditions.

3.2.6.1 Turbine Passage

Direct mortality occurs within the confines of a turbine. Based on inferential data and knowledge of turbine conditions, it is assumed that direct mortality can originate from mechanical, pressure or hydraulic-related factors. Mortality due to mechanical factors may result from fish striking the blades or passing through gaps between turbine components. Pressure or hydraulic-related mortality probably occurs as fish pass through areas of cavitation, hydraulic shear, or other areas where pressure or velocity change may cause injury or death (Normandeau Associates and Skalski 1997).

Indirect mortality occurs after fish, particularly juvenile fish, have left the turbine. The principal cause of indirect mortality of juvenile fish is likely predation by fish or birds (Poe and Rieman 1988). This most likely occurs in the tailrace as the juveniles recover from the disorientation and stress of turbine passage (Ledgerwood et al. 1990). Passage may also create harmful levels of physical or behavioral stress, leading to a weakened resistance to disease and subsequent delayed mortality (Ferguson 1994).

Estimates of turbine survival in other Columbia River Basin projects vary from 98 to 81percent (Whitney et al. 1997). The average survival rate reported from direct recapture studies is 94.5 percent. In tests that included some level of indirect mortality (including predation on disoriented fish), the survival levels averaged about 89 percent (Whitney et al. 1997). However, these average estimates include some data collected prior to the implementation of predator abatement programs, as well as for older (less efficient) turbine units. More recent evaluations, conducted under turbine operations presumed to provide the best passage conditions for fish (i.e., within 1 percent of peak power efficiency), indicate greater survival rates. Turbine survival studies in the Snake River between 1993 and 1997 indicate an average turbine survival rate of about 91 percent (Muir et al. 2001; NMFS 2000a). This estimate represents the best available information, but was not derived from the Mid-Columbia River projects, and therefore may not be directly comparable. Based on available information, turbine passage survival, considering both direct and indirect components of mortality, is likely between 90 and 93 percent.

Wells Dam

Approximately 8 percent of the juvenile salmon and steelhead migrants pass through the Kaplan turbines at the Wells Dam (Skalski 1993). However, no specific estimates of turbine passage survival exist at the Wells Dam following improvements made to the Kaplan turbine units in the early 1990s, or after implementing predator abatement programs. Therefore, a range of 90 to 93 percent average survival levels observed in recent studies on the Snake River is expected to best represent the current passage conditions through turbine units at the Wells Dam (NMFS 2000b). However, this estimated survival range does not include delayed mortality rates. Survival evaluations conducted between 1998 and 2000 provide overall project passage survival rates at

Wells Dam, and are discussed below under Total Project Survival – Juvenile Migrants (Section 3.2.6.4).

Rocky Reach Dam

The direct survival of chinook salmon smolts passing through the Kaplan turbines at the Rocky Reach Dam was assessed during two balloon-tag studies, in 1993 and 1996. The 1993 study estimated passage survival at 94 percent (RMC Environmental Services and Skalski 1994). The 1996 tests measured survival rates of 95 percent for a new turbine unit (Unit 6) and 96 percent for an original Kaplan turbine (Unit 5) (Normandeau Associates and Skalski 1996).

The PUD has begun a multi-year process to install new turbines across the powerhouse. These replacement turbines are designed to reduce the gap between the blade and runner that is considered to be one cause of direct turbine mortality. Also, the new turbines have a higher efficiency rating than the original turbines. Fish passage survival is generally considered higher for more efficient turbines and operations at peak turbine power efficiency (Bell 1981). There are no comparatively unique features at the Rocky Reach Dam that would indicate significantly different levels of indirect mortality compared to other facilities. Therefore, the 90 to 93 percent survival rate range discussed above likely represents turbine passage survival for all species at the Rocky Reach Dam.

Based on juvenile radio-telemetry evaluations conducted in 1998, approximately 35 percent of the steelhead and 53 percent¹ of the spring-run chinook salmon passed the project via the

¹ Radio-tagged fall-run chinook salmon obtained from the East Bank Hatchery had considerably higher powerhouse passage rates in 1998 (approximately 81 percent powerhouse passage [English et al. 1998a]). It is unclear at this time why the *naïve* hatchery fish passed the project via the powerhouse at substantially higher rates than the experienced fish trapped at the surface bypass system and then released back upstream of the project.

powerhouse (English et al. 1998a). In 1999, Lady et al. (2000) estimated that approximately 27 percent of the radio-tagged steelhead passed the project via the powerhouse and English et al. (1999) estimated that 58 and 40 percent of the radio-tagged spring-run chinook salmon and steelhead passed the project via the powerhouse, respectively. A similar study in 2000 reported 54 percent of spring-run chinook salmon and 32 percent of steelhead passing through the Rocky Reach Dam powerhouse (English et al. 2000). An acoustic-tag evaluation in 2000 found about 48 percent of the chinook salmon and 41 percent of the steelhead passed through the powerhouse (Steig et al. 2001).

Sockeye salmon appear to have a higher turbine passage rate than either chinook salmon or steelhead. Similar powerhouse passage estimates for sockeye salmon (67 and 68 percent) were observed in 1998 and 2000 (English et al. 1998a; 2000). A slightly higher percentage (74 percent) of sockeye salmon passed the project through the powerhouse in 1999 (English et al. 1999).

Normandeau Associates and Skalski (1996) estimated average direct survival of balloon-tagged fall-run chinook salmon passing through the old Kaplan units at 96 percent, and 95 percent for the newly rebuilt Kaplan units. Average survival through the fixed blade units for balloon-tagged hatchery reared fall-run chinook salmon was estimated at 94 percent (RMC Environmental Services and Skalski 1994).

The most significant difference between the balloon-tag evaluations conducted in 1993 and 1996 had to do with operation of the test units. In 1993, the units had no restrictions and were operated as needed to meet load. In 1996, load was kept constant throughout the test. This may help explain the variability seen in the results between the two years, and may better indicate the range of possible survival levels during normal turbine unit operations. Although neither evaluation was able to discern the indirect effects associated with powerhouse passage, the pilot

level survival evaluation conducted using radiotagged steelhead in 1999 estimated the combined direct and indirect survival at about 90 percent (Lady et al. 2000), suggesting that the indirect effects associated with turbine passage are more significant than those seen at the bypass system or spillway. However, the validity of using radiotelemetry data to assess juvenile fish passage survival has not been determined. Such studies are affected by many of the same uncertainties identified for adult survival studies using radiotelemetry methods.

Rock Island Dam

Between approximately 70 and 75 percent of the juvenile Upper Columbia River spring-run chinook salmon and steelhead pass through the turbines at the Rock Island Dam (Iverson and Birmingham 1998; Lady et al. 2000). Normandeau Associates and Skalski (1997) estimated the direct survival of fall-run chinook salmon passing through the Nagler turbines at Powerhouse 1 at about 93 percent. They estimated direct survival through the bulb turbines and Kaplan-type turbines at Powerhouse 2 at about 96 percent. Powerhouse 2 has unique features which are likely to result in higher survival rates relative to most powerhouses in the basin. For example, the relatively long draft tubes (100 feet) likely result in decreased indirect mortality through the turbines compared to turbines at other projects. This is likely for two reasons. First, the point of egress is relatively far away from the dam itself, making juveniles less vulnerable to predacious fishes. Second, the flows exiting the long draft tubes are relatively less turbulent, which would reduce the vulnerability of juveniles to avian predators.

Unfortunately, none of these route-specific estimates account for indirect survival, which has yet to be evaluated with proven technologies at Rock Island Dam. Although using radio telemetry techniques to assess survival has yet to be independently verified, as discussed earlier,

the results do support these initial conclusions that turbine passage survival is likely between 90 and 93 percent at Powerhouse 1 and between 90 and 93.5 percent at the Powerhouse 2.

3.2.6.2 Spill Passage

Survival of fish passing through spillways of Columbia River dams has been generally estimated at between 98 and 100 percent (Anderson et al. 1993; Whitney et al. 1997, NMFS 2000a, Muir et al. 2001). In the absence of project specific data, these estimates are considered the best available estimates of spill passage survival.

Wells Dam

Five of eleven spill bays at the Wells Dam have been modified to function as a juvenile bypass system. These modifications increase water velocities to attract surface oriented fish, which are then bypassed through the spillway. Detailed discussions of the Wells Dam bypass are provided in Section 3.2.6.3 (Juvenile Bypass Systems). In lieu of additional specific information, however, a 98 to 99 percent average survival rate is assumed for the anadromous salmonids passing through Wells Dam via the spillway.

Rocky Reach Dam

Pursuant to the Fourth Revised Interim Stipulation for the Rocky Reach Dam (now expired), Chelan County PUD is obligated to provide up to 30 days of spill during the spring migration period, with an additional 6 days of spill (if necessary) to cover the middle 90 percent of the Okanogan sockeye salmon outmigration. Spill is provided at a level of 15 percent of the previous day's average flow, distributed over a 24-hour period. Information acquired in recent years indicates that the middle 95 percent of the spring-run chinook salmon and steelhead outmigrations range from 30 to 48 days at the

Rocky Reach Dam, averaging 42 days for steelhead and 41 days for spring-run chinook salmon. During the summer, the Chelan County PUD spills 10 percent of the previous day's average flow for a total of 34 days between June 15 and August 15.

Chelan County PUD has also voluntarily modified the Rocky Reach spill program to provide the 15 percent spill level during a period coinciding with 95 percent of the outmigration of spring-run chinook salmon and steelhead (typically April 20 to June 15). As well as a 15 percent spill level during the summer migration period of subyearling chinook salmon (typically July 1 to August 15). The voluntary program also provides a 25 percent spill level (for up to 21 days) to aid the outmigration of Okanogan River sockeye salmon.

Hydroacoustic studies conducted over several years at the Rocky Reach Dam have shown that an average of 8 percent of the spring migrating smolts pass through the spillway in 15 percent spill (Steig and Adeniyi 1997). However, similar spill levels in 1998 through 2000 resulted in an average passage rate of about 14 percent for spring-run chinook salmon, 12 percent for steelhead, and 21 percent for sockeye salmon (English et al. 1998a, 1999, 2000).

Only one estimate of spillway survival exists for the Rocky Reach Dam, and that was estimated with coho salmon through a single spill bay in 1980 (Heinle and Olson 1980). The results of this evaluation indicated that survival may be comparatively high, approximately 99 percent. Whitney et al. (1997) also reviewed several spillway survival studies in the Columbia River Basin and concluded that spillway survival is typically at least 98 percent. This estimate is supported by the 99 percent spillway survival estimate for coho salmon at the Rocky Reach Project. In lieu of additional specific information however, a 98 to 99 percent average survival rate is assumed for the anadromous salmonids bypassing the Rocky Reach spillway.

Rock Island Dam

As established in the 1987 Rock Island Settlement Agreement, spill at Rock Island Dam is accomplished through a Fisheries Conservation Account, which allows the fishery regulatory agencies to request spill at their discretion up to an annual limit of \$2.05 million in lost energy revenue (based on 1986 dollars adjusted for inflation). Although the preferred method for increasing juvenile passage survival at the Rock Island Dam is through the use of spill, discharge has been limited due to total dissolved gas production. In an effort to increase spill efficiency, the PUD has modified 9 of the 33 spill gates to allow for more surface oriented spill. The modified surface spill gates, or notched gates, utilize a maximum of about 2,000 cfs per spill bay and have been found under certain conditions to pass comparatively more fish per volume of water than the existing spill bays (Ransom and Steig 1995).

Similar to the operations at Rocky Reach Dam, Chelan County PUD currently voluntarily provides spill levels equivalent to 20 percent of the daily flow during the period encompassing about 95 percent of the spring and summer juvenile migration periods (typically April 15 to June 15 and July 15 to August 15, respectively). During the 1998 spring migration, the Chelan County PUD spilled approximately 25 percent of the total river flow for fish passage on a 24-hour basis. At this spill level, both the modified surface spill gates and several of the unmodified spill bays were utilized. Hydroacoustic studies estimated that approximately 27 percent of the yearling chinook salmon and 26 percent of the juvenile steelhead passed through the spillway in 1998 (Iverson and Birmingham 1998). Radio telemetry evaluations in 1999 and 2000 estimated that 30 percent of steelhead smolts (Lady et al. 2000) and 25 percent of chinook salmon (Skalski et al. 2000) passed the project through the spillway.

Direct survival estimates through particular spill bays for hatchery-reared chinook salmon were calculated in 1997 by Normandeau Associates and Skalski (1998). The direct survival through the notched weirs was estimated at about 95 percent and the direct survival through the unmodified spill bays was estimated at approximately 98 percent.

Normandeau Associates and Skalski (1998) concluded that the reduced survival levels calculated through the notched weirs may have resulted from the associated shallow stilling basin at spillbay 21 and the reduction in discharge through the notched weirs. They also noted that the 1,000 cfs of water discharged through the notched weirs had a much more pronounced plunge than the shallower, downstream projection of the 10,000 cfs discharged through the unmodified spill bay. A subsequent survival study estimated survival through both modified and unmodified spillways at between 99.5 and 100 percent (Normandeau Associates 1999). Lady et al. (2000) also estimated spillway survival at about 100 percent for radio-tagged steelhead.

Given the configuration of the Rock Island spillway (i.e., no downstream ogee, plunging flow), it is probable that some level of indirect mortality occurs in the tailrace, but there is not adequate data for accurate estimates. Therefore, a spill passage survival rate of 98 to 99 percent likely represents a conservative estimate of survival, including direct and indirect mortality sources.

3.2.6.3 Juvenile Bypass Systems

Estimates of the direct survival rate of juvenile salmon and steelhead through bypass systems includes mortality rates associated with turbine intake screens, gatewells, orifices, bypass flumes, dewatering screens, sampling facilities (including holding tanks), and bypass outfall conduits. Estimates of direct bypass mortality found at sampling facilities for the bypass systems at the

Federal hydroelectric projects on the Snake and Lower Columbia Rivers suggest that the direct mortality of both wild yearling steelhead and chinook salmon is generally less than 1 percent (Martinson et al. 1997; Spurgeon et al. 1997; summarized in NMFS 2000a), although some level of stress or injury may result in mortality later in the life cycle. Bypass survival may also be indirectly affected by predation at poorly located outfall sites or by delayed mortality associated with injury caused by the bypass system. Bypass system outfalls that concentrate juvenile salmon and steelhead into a comparatively small volume of water may cause high levels of predation related mortality. Muir et al. (2001) estimated direct and indirect survival estimates of between 95.4 and 99.4 percent for yearling chinook salmon passing through bypass systems on the Snake River. Survival estimates for steelhead were slightly lower, ranging from 92.9 to 98.3 percent.

Additional research efforts are focusing on surface collector bypass systems owing largely to the success of the Wells Dam bypass system completed in 1989. Since juvenile anadromous fish tend to migrate in the upper portion of a reservoir, surface collector systems attempt to provide attraction flow higher in the water column than the attraction flow being created by the turbines. The Wells Dam system includes vertical baffle slots to create attraction flow into the spillway bypass, while other prototype systems are examining shallow skimmer weirs and orifices similar to the sluiceways at the Ice Harbor and The Dalles dams (BPA et al. 1994b).

Wells Dam

Hydroacoustic studies conducted from 1990 through 1992 at Wells Dam estimated that 92 percent of the spring outmigrants (which include steelhead, spring-run chinook, and sockeye salmon) were guided through the juvenile bypass system (Skalski 1993). These estimates have been supported by similar information collected

during concurrent fyke net evaluations (Bickford 1997). A juvenile chinook salmon balloon-tag study that was conducted in 1993 concluded that there was no measurable direct injury or mortality through the bypass system (RMC Environmental Services, Inc. 1993).

Although this study did not measure the effect of predation in the tailrace on juveniles disoriented or stressed from passage through the bypass system, juveniles are not concentrated in reduced flow in a particular area of the tailrace. Therefore, predation of bypassed smolts in the tailrace may be lower than other bypass systems that have concentrated outfall locations that tend to attract predators. In addition to the potentially reduced predation rates, the limited spill volumes required by the bypass system minimizes the total dissolved gas levels downstream. However, in the absence of specific evaluations of indirect mortality rates at the Wells Dam, the total direct and indirect mortality is likely less than the 2 percent found at the Lower Snake River project bypass systems (NMFS 2000c).

The PUD is required by the Wells Settlement Agreement of 1990 to operate the bypass system to provide a non-turbine passage route for at least 80 percent of the juvenile spring and summer migrants passing Wells Dam. Since 1998, Douglas County PUD has voluntarily operated the bypass system to provide passage over at least 95 percent of the juvenile spring and summer migrations, consistent with the terms of the 1998 HCP Implementation Agreement. In 1999, the bypass was operated during 98.2 percent of the migration period (Wells Coordinating Committee, unpublished data). The coordinating committee bypass team determines the operation dates for the Wells bypass system by utilizing monitoring information from hydroacoustic transducers installed in the forebay of the Wells Dam. Given that the Wells bypass is a modification of the Wells spillways, bypass survival is expected to be similar to spillway survival which is estimated to range from 98 to 99 percent.

Rocky Reach Dam

The new juvenile bypass system, being constructed to replace the prototype system at the Rocky Reach Dam, includes one surface collection entrance and intake guidance screens in turbine units 1 and 2. Passage efficiency evaluations in the mid-1990s to early 2000s indicate generally lower bypass efficiency for juvenile sockeye and chinook salmon than for steelhead. Passage efficiency tests conducted in 1998 showed that approximately 39 percent of the radio-tagged yearling chinook salmon, 10 percent of sockeye, and 51 percent of the steelhead passed the project via the juvenile bypass (English et al. 1998a). Similar radio telemetry studies in 1999 and 2000 reported chinook salmon passage rates of 26 and 28 percent, respectively; sockeye salmon passage rates were 11 and 6 percent, respectively (English et al. 1999, 2000). Bypass rates for steelhead were 49 and 57 percent in 1999 (English et al. 1999; Lady et al. 2000), and 57 percent in 1999 (English et al. 2000).

Several other tagging methods have also been used to assess fish passage efficiencies of the Rocky Reach juvenile bypass system, with generally similar results. PIT-tag studies conducted in 1999 and 2000 indicated that 22 to 51 percent of the yearling chinook salmon used the bypass (Mosey et al. 1999, 2000; Murphy et al. 2001). These same studies also estimated steelhead passage at 27 to 61 percent. Studies conducted in 2000 using acoustic-tagged fish found that 38 percent of the chinook salmon and 50 percent of the steelhead passed through the bypass (Steig et al. 2001). PIT-tag evaluations of sockeye and subvearling chinook salmon, showed bypass efficiencies of 7 to 29 percent and 27 to 39 percent, respectively (Peven and Mosey 1998; Mosey et al. 1999, 2000; Murphy et al. 2001).

The fish passage efficiency of the bypass is influenced by the proportion of fish that pass the project through the spillway before they reach the area of influence of the bypass. The combined

spillway and bypass efficiencies (total fish passage efficiency) using the 1998 through 2000 radio- and acoustic-tag data (cited above) ranged from 42 to 52 percent for chinook salmon, and from 59 to 73 percent for steelhead. Similarly, radio-telemetry assessments with sockeye salmon in 1998 through 2000 found total fish passage efficiencies of 26 to 33 percent (English et al. 1998a, 1999, 2000).

In the 1998 evaluations, however, there were significant differences noted between passage efficiency rates of *naïve* hatchery chinook salmon (chinook salmon previously unexposed to the bypass system) and run-of-the-river chinook salmon captured in the bypass system then tagged and released back upstream for evaluation. In 1998, the bypass efficiency for naïve hatchery chinook salmon was substantially lower (19 percent) than those that had previously entered the bypass system (40 percent) (English et al. 1998a). The primary reason for this difference is the higher proportion of the hatchery fish that were first detected at the turbine gatewells or passed the project via the spillway. As a result, a high proportion of the hatchery fish were not available to be guided by the bypass system. It is unknown at this time which population more accurately represents the run at large. Therefore, both estimates are considered in the efficiency estimates.

To determine the rate of injury that may be caused by the bypass system at Rocky Reach, samples of yearling chinook salmon, selected to preclude prior injury, have been released into the surface collector and turbine intake systems and subsequently captured and reexamined for injury. These tests have shown descaling and injury rates attributable to passage through the downstream collection entrance were generally less than 2 percent (Peven et al. 1995, 1996; Peven and Mosey 1998). In 1998, however, 4.4 percent of yearling chinook salmon released into the upstream collector entrance had evidence of scale loss or injury (Mosey et al. 1999). In 1999, by improving hydraulic conditions in turbine intakes

and at the fish diversion screens of units 1 and 2, the PUD improved fish passage conditions, and thereby reduced the scale loss and injury rates.

No measurements of indirect mortality are available to determine the survival of smolts after they pass through the bypass outfall pipe. Studies of subyearling chinook salmon bypass mortality at Bonneville Powerhouse 1 and Powerhouse 2 (Ledgerwood et al. 1990, 1994; Dawley et al. 1996) indicate that high bypass mortality may be associated with predation that occurs at a poorly sited bypass outfall. The temporary bypass outfall site, located in front of the turbine unit three upwelling, was not situated using the current knowledge of predator behavior (e.g., Loch et al. 1994; Mesa and Olson 1993). Therefore, predation mortality may be significant at the temporary site.

However, the PUD has implemented measures to reduce indirect mortality caused by predation in the tailrace. Avian predator hazing by propane cannons and bird exclusion wires across the tailrace reduces bird predation on smolts. Also, the PUD will continue the northern pikeminnow removal program that has removed more than 5,500 predators annually from the tailrace since 1994 (West 2002 personal communication). With improved hydraulic conditions at the intake screens, and with a properly sited bypass outfall, survival through the Rocky Reach bypass system is expected to equal the 97 to 98 percent survival rate estimated for bypass systems throughout the basin (see Table 2-4).

Rock Island Dam

Powerhouse 2 is equipped with a passive bypass system (no intake screens for guidance) that allows fish to volitionally enter turbine unit gatewells and exit them via bypass orifices to a collection channel that leads to a fish sorting collection raceway. The annual passage of juvenile spring-run chinook salmon through this system has ranged from 8,500 to 33,500 from 1985 to 1996 (Fish Passage Center 1985 - 1996).

Although the percentage of the total population is small, this facility provides useful monitoring information for Upper Columbia River fish stocks. Due to the small numbers of fish using this system, survival rates are not known. However, it is reasonable to assume that survival is similar to other bypass systems in the basin at 97 to 98 percent (see Table 2-4).

3.2.6.4 Total Project Survival – Juvenile Migrants

Total project survival for juvenile migrants is defined as the percentage of each Plan species that survives through the reservoir, forebay, dam, and tailrace of an individual project, including direct, indirect, and delayed mortality wherever it may occur and can be measured given the available technology. The preferred technology is the use of passive integrated transponder tags (PIT-tags) in paired-release mark and recapture studies that compare the survival of a test group of fish released at the head of the reservoir with a control group of fish released in the project tailrace.

In contrast, single release-recapture models can only measure project effects from the point of release to the point of mixing downstream of the PIT-tag detector (which is typically located within a juvenile bypass channel or fish handling facility). Thus, not all of the mortality associated with passage via turbines or the spillway or in the tailrace of the project is included in these survival estimates. Therefore, these survival estimates are likely somewhat higher than would have been measured if the paired release-recapture model had been utilized.

Unfortunately, methodologies do not currently exist to measure total project survival for all Plan species. The number of fish available; the size, health, and fragility of the fish during their outmigrations; and the detectability of certain species at downstream collector sites all affect the feasibility of utilizing mark and recapture techniques. As an alternative, survival estimates

measured for certain species through a particular passage route can be combined with estimates of fish passage efficiency to calculate an estimate of dam passage survival (i.e., a calculated survival estimate). Although these estimates do not include tailrace or reservoir survival, or estimates of indirect mortality, they can be used to generally identify expected dam passage survival if other specific survival information is unavailable.

This section discusses the results of estimating total project survival for juvenile salmon and steelhead using both the mark-recapture and the passage route calculation techniques, at each of the projects, in an attempt to determine the overall range of expected survival. Because of the specific assumptions required for each methodology, varying environmental conditions, and the annual and behavioral differences in each of the species, these estimates tend to vary by year, by species, and by estimation technique. In addition, the majority of the available information was developed specifically for yearling springrun chinook salmon and steelhead. This information is generally assumed to represent other salmon species where specific information is unavailable, pending additional studies specific to those fish.

The cumulative effects (i.e., the effects of multiple dam passage on juvenile fish) are not clearly accounted for with either methodology.

Wells Dam

Juvenile survival through Wells Dam is considered to be high when compared to other dams on the Columbia and Snake Rivers. This is due to its highly effective bypass system (passing about 92.4 percent of the juvenile spring migrants and about 96.4 percent of the summer migrants through non-turbine routes). The survival rate through the bypass system is assumed to be 98 to 99 percent. Multiplying the estimated spring-run passage rate (92.4 percent) of the bypass system by the estimated survival rate and the proportion

of the run (80% of the spring and summer migrations)² covered by the bypass operation period under the Wells Settlement Agreement, indicates that approximately 72.4 to 76.4 percent of the spring migrants and 75.6 to 76.4 percent of the summer migrants would utilize bypass route of passage and survive (Table 3-4). The remaining 7.6 percent of the spring migrants and 3.6 of the summer migrants, that do not pass through the bypass during the bypass operation period and 100 percent of the fish passing the project when the bypass is not operating, are assumed to pass through the turbines. The turbine survival rate is estimated at 90 to 93 percent survival rate (based on data collected throughout the basin). Thus, an estimated 23.5 to 24.3 percent of spring migrants and 20.6 to 21.3 percent of summer migrants utilize the turbine route of passage and survive. Adding these route passage survival estimates results in a calculated total dam passage survival rate ranging from 95.9 to 97.4 percent for spring migrants and 96.2 to 97.6 percent for summer migrants.

Because, species-specific passage rates are not available for the Wells Project, these calculated survival estimates are assumed to be the same for all the spring migrating anadromous salmonid species that pass the dam. The summer migrant estimates of bypass efficiency were collected during the subyearling chinook salmon migration (summer migration) and reflect their guidance rate through the bypass system. However, survival rates are expected to vary to a degree by species and by year (due to differences in river flow and fish conditions etc).

In addition to these calculated dam passage survival estimates, survival studies have been conducted to assess total project passage survival.

² This assumes that the bypass system operates for 80% of the run as presented in Alternative 1 as the minimum requirement under the Wells Settlement Agreement. However, Douglas County PUD has operated the bypass system in recent years in accordance with the 1998 HCP agreement to encompass at least 95% of the outmigration.

CALCULATED JUVENILE FISH PASSAGE SURVIVAL ESTIMATES BY PASSAGE ROUTE (ALTERNATIVE1) TABLE 3-4.

	CALCULATED SURVIVAL		TIMATES THROU	ESTIMATES THROUGH INDIVIDUAL PASSAGE ROUTES DURING THE SPILL AND BYPASS OPERATION PERIODS 1	ASSAGE ROUTE	S DURING THE	TURBINE SURVIVAL FOR	ALL ROUTES
SPECIES	SPILLWAY PASSAGE (%)	SPILLWAY SURVIVAL (98-99%)	BYPASS PASSAGE (%)	BYPASS SURVIVAL ²	TURBINE PASSAGE (%)	TURBINE SURVIVAL (90-93%)	Non-Bypass Period (90-93%)	COMBINED — TOTAL SURVIVAL (%)
Wells Dam								
Subyearling Chinook	A Z	۷ Z	96.4	75.6 – 76.4	3.6	2.6 – 2.7	18.0 – 18.6	96.2 - 97.6
Yearling Chinook	AA	Ą	92.4	72.4 – 73.2	7.6	5.5 – 5.7	18.0 – 18.6	95.9 – 97.4
Sockeye	NA A	A A	92.4	72.4 – 73.2	7.6	5.5 - 5.7	18.0 - 18.6	95.9 – 97.4
Coho	NA	AA	92.4	72.4 – 73.2	7.6	5.5 - 5.7	18.0 – 18.6	95.9 – 97.4
Steelhead	A N	NA	92.4	72.4 – 73.2	7.6	5.5 - 5.7	18.0 – 18.6	95.9 – 97.4
Rocky Reach Dam ³								
Subyearling Chinook	12.0	9.9 – 10.0	Y	N A	88.0	66.9 -69.2	14.0 –1 4.4	90.8 - 93.6
Yearling Chinook	13.8	11.4 – 11.5	A'N	NA	86.2	65.6 67.7	14.0 –1 4.4	90.9 – 93.7
Sockeye	21.5	17.8 – 18.0	N A	N A	78.5	59.7 - 61.7	14.0 –1 4.4	91.5 – 94.1
Coho	13.8	11.4 – 11.5	A A	A N	86.2	65.6 - 67.7	14.0 –1 4.4	90.9 – 93.7
Steelhead	12.5	10.4 - 10.5	₹ Z	A	87.5	66.5 - 68.8	14.0 –1 4.4	90.8 – 93.6
Rock Island Dam ⁴								
Subyearling Chinook	16.5	12.9 - 13.1	N A	N A	83.5 ⁶	$60.2 - 62.5^5$	18.0 - 18.6	91.1 – 94.2
Yearling Chinook	23.7	18.6 - 18.8	A A	NA	76.3 ⁶	$54.9 - 57.0^5$	18.0 - 18.6	91.5 – 94.5
Sockeye	24.0	18.8 - 19.0	NA	N A	76.0 ⁶	$54.8 - 56.8^5$	18.0 - 18.6	91.5 – 94.5
Coho	23.7	18.6 – 18.8	NA	A V	76.3 ⁶	$54.9 - 57.0^5$	18.0 – 18.6	91.5 – 94.5
Steelhead	24.6	19.3 – 19.5	NA	NA	75.4 ⁶	54.3 – 56.4 ⁵	18.0 – 18.6	91.6 – 94.6

Dam passage survival calculations are based on assumed survival and passage rates for available routes. Although the Rocky Reach survival ranged from 93.3% to Assumes 98 to 99% survival for the Wells bypass and 97% to 98% at Rocky Reach, although Alternative 1 assumes no bypass operations at Rocky Reach Dam. 96.7% with the prototype bypass system operating, the bypass is excluded from Alternative 1 for comparative purposes (as it is an integral part of Alternative 3).

Assumes 15% spill flow during 84% of the spring and summer migrations.

Assumes 16% and 11% spillway flow during 80% of the spring and summer migration periods, respectively.

⁵ Upper range at Rock Island Dam is based on an assumed 93.5% survival through Powerhouse 2; low range assumes 93.0% survival through both powerhouses.

⁶ Combined Powerhouses 1 and 2.

NA = Not available.

Project passage survival includes direct, indirect, and delayed mortality related to passing the project, and also the direct and indirect mortality associated with passage through the reservoir. Bickford et al. (1999) report a project passage survival rate of 99.7 percent for PIT-tagged chinook salmon from the Methow River to below the dam when the bypass was operating (Table 3-5). Similar studies with steelhead in 1999 and 2000 estimated project passage survival rates of 94.3 percent and 94.6 percent, respectively (Bickford et al. 2000a,b). The juvenile project passage survival rate estimates are greater than the 93 percent juvenile project passage survival goal established in the HCP, although additional survival estimates would be needed to assess

survival rates for sockeye and subyearling chinook salmon.

Rocky Reach Dam

Based on the available information for various species, between 12 to 22 percent of juvenile fish pass through the spillway with a 15 percent spill level and between 19 and 63 percent of the juvenile fish pass the dam through the prototype bypass system (see Table 3-4). Approximately 24 to 60 percent of juvenile fish (again, varying by species) pass the project via the turbines. However, for comparative purposes Alternative 1 does not include the bypass. Without the bypass system operating, about 78.5 to 88 percent of the juvenile fish would pass through the powerhouse.

TABLE 3-5. SUMMARY OF JUVENILE PROJECT SURVIVAL STUDIES FOR WELLS, ROCKY REACH, AND ROCK ISLAND DAMS, 1998 THROUGH 2002

YEAR	STOCK ¹	Tagging Method	STATISTICA L MODEL ²	SURVIVAL ESTIMATE (%)	STANDARD ERROR (%)	Reference
Wells						
1998	Chinook (H)	PIT-tag	PRR	99.7	1.5	Bickford et al. 1999
1999	Steelhead (H)	PIT-tag	PRR	94.3	1.6	Bickford et al. 2000a
2000	Steelhead (H)	PIT-tag	PRR	94.6	1.5	Bickford et al. 2001
Rocky Reach	1					
1998	Chinook (H)	PIT-tag	PRR	0.859	4.2	Eppard et al. 1999
1998	Chinook (H)	PIT-tag	SRR	0.939	4.2	Bickford et al. 1999
1999	Steelhead (H)	PIT-tag	SRR	0.959	1.0	Bickford et al. 2000b
1999	Steelhead (ROR)	Radio-tag	PRR	0.966	3.8	Stevenson et al. 2000
2000	Steelhead (H)	PIT-tag	SRR	0.967	8.0	Bickford et al. 2001
Rock Island						
1998	Chinook (H)	PIT-tag	PRR	0.889	3.9	Eppard et al. 1999
2000	Chinook (H)	PIT-tag	PRR	0.918	3.4	Stevenson et al. 2000
2000	Chinook (H)	Radio-tag	PRR	0.947	1.9	Stevenson et al. 2000
2000	Chinook (ROR)	Radio-tag	PRR	0.939	1.6	Stevenson et al. 2000
2001	Chinook (H)	PIT-tag	PRR	0.922	1.0	Skalski et al. 2001
2002	Chinook (H)	PIT-tag	PRR	0.956	2.5	Skalski et al. 2002
2002	Chinook (H)	Acoustic Tag	PRR	0.952	2.6	Skalski et al. 2002
1999	Steelhead (H)	PIT-tag	PRR	0.958	1.4	Stevenson et al. 2000
1999	Steelhead (H)	Radio-tag	PRR	0.998	4.7	Stevenson et al. 2000
2000	Steelhead (ROR)	Radio-tag	PRR	0.920	1.7	Skalski et al. 2001

¹ H = hatchery, ROR = run-of-the-river

² PRR = paired release-recapture, SRR = single release-recapture

Multiplying the 12 to 22 percent spill passage rate (this assumes that none of the fish that would have used the prototype use spill to pass the dam) by the 98 to 99 percent spill survival rate (estimated from other projects) and the proportion of the migration period covered by spill indicates that about 9.9 to 18.0 percent of the juvenile migrants are passing via the spillway and surviving (see Table 3-4). Multiplying the turbine passage rates (including the period when spill is not provided) by the 90 to 93 percent turbine survival rate results in about 73.7 to 83.6 percent of smolts are passing the project via the powerhouse and surviving. Adding the survival estimates for the two passage routes indicates an overall dam passage survival ranging from about 90.8 to 94.1 percent (see Table 3-4). Although the Rocky Reach bypass is not included in Alternative 1 (for comparison purposes), if the bypass were operated according to the HCP agreements, the overalls survival rates at Rocky Reach Dam would range from 93.3 to 96.7 percent (assuming the new bypass has the same efficiency as the prototype).

In addition to these calculated dam passage survival estimates, some information relating to project survival (dam and reservoir) is available (see Table 3-5). Although the various methodologies are not directly comparable (they differ with respect to the elements of direct, indirect, and delayed mortality incorporated into the estimates—for example, see discussion at Section 3.2.6.4 [Total Project Survival – Juvenile Migrants | regarding paired-versus single-release recapture models), each method includes at least some, if not most, of the direct, indirect, and delayed mortality factors associated with the project. The PIT-tag and radio-tag survival studies conducted in 1998 with hatchery reared yearling fall-run chinook salmon suggest project passage survival rates (reservoir and dam passage) are in the range of 86 to 94 percent (Bickford et al. 1999; Eppard et al. 1999; see Table 3-5). However, the higher survival estimate was derived from a single-release evaluation that does not include all of the indirect

and delayed mortality factors. The 1999 and 2000 PIT-tag survival evaluations estimated project passage survival at 96 and 97 percent for hatchery steelhead, although these evaluations also consisted of a single-release protocol (Bickford et al. 2000b; Bickford et al. 2001). A radio-telemetry evaluation in 1999 estimated project passage survival rate to be about 97 percent for run-of-the-river steelhead (Stevenson et al. 2000). Although this radio-telemetry study included paired releases, and therefore includes most indirect and delayed mortality factors, the accuracy of radio-telemetry data for assessing juvenile survival has not been fully evaluated, and the results could be (for several technical reasons) biased high, although they were virtually identical with the single-release estimates (see Table 3-5).

Rock Island Dam

Based on available information, approximately 75 to 84 percent of the juvenile outmigrants will pass the Rock Island Dam via the powerhouses and about 17 to 25 percent pass via the spillway (see Table 3-4). Under the current operating conditions, the estimated spillway survival rate is about 98 to 99 percent. Multiplying the spillway passage rate by the spillway survival rate and the proportion of the migration period covered by spill operations (80 percent), results in about 13 to 20 percent of all smolts pass the project via the spillway and survive. The estimated smolt survival rate through the Rock Island turbines is between 90 and 93 percent at Powerhouse 1 and between 90 and 93.5 percent at Powerhouse 2. Multiplying the turbine passage rate (including the period when no spill is provided) by the estimated turbine survival rates indicates that about 72 to 81 percent of the fish pass the project via the turbines at both powerhouses and survive. Adding spill and powerhouse survival results in approximately 91 to 95 percent survival through Rock Island Dam (see Table 3-4). This overall range of calculated survival rates is within the range of estimates obtained through tagging studies (89 to 99 percent), which include reservoir and dam passage (see Table 3-5). All of these evaluations were pair-released studies, although some were based on radio-telemetry or acoustic tag technology, which have not been full evaluated (see Table 3-5 and previous discussion for Rocky Reach Dam).

3.2.7 OVERALL FISH PASSAGE SURVIVAL

The HCPs establish an overall survival rate goal of 91 percent for adult and juvenile passing the Mid-Columbia River projects. However, obtaining robust estimates of adult salmon and steelhead survival is difficult, and none of the technologies currently available can differentiate between natural mortality, which undoubtedly occurs, and project-related mortality. For example, adult survival estimates in several unimpounded rivers in British Columbia, Canada ranged between 70 and 90 percent for spring-run chinook salmon and between 31 and 83 percent for summer-run steelhead and was dependent upon environmental factors like flow (Koski et al. 1993, 1994, 1995, 1996a,b).

At this time, there is little information related to the survival of adult anadromous salmonids passing the Mid-Columbia River projects. Stuehrenburg et al. (1995) provided minimum survival estimates of 77.8 to 88.9 percent for spring-run chinook salmon migrating to spawning areas in the Columbia River upstream of Priest Rapids Dam, approximately corresponding to a range of per-project survival estimates of 95.1 to 97.7 percent. However, these data are unreliable because of problems associated with the tags. receivers, and software used at the time (Wainwrite et al. 2001). In addition, many of the tagged fish were likely fish from Ringold Hatchery straying upstream of Priest Rapids Dam. Because many of these fish would eventually fall back through the dams in order to reach the hatchery, their behavior also biases the study. For these reasons, the minimum survival estimates from this study are likely biased low i.e., the actual survival was likely higher than the numbers reported).

Analysis conducted as part of the 2000 Federal Columbia River Power System biological opinion estimated total (natural and project-related) per project survival rates (current and under the reasonable and prudent alternatives outlined in the biological opinion) was about 98 percent for adult Upper Columbia River spring-run chinook salmon and 97 percent for adult Upper Columbia River steelhead. NMFS believes these are the best available estimates and are generally applicable to the FERC-licensed projects on the Columbia River.

As previously noted, it is currently not possible to determine what fraction of the observed mortality rates is attributable to the affects of the hydroelectric projects, and what fraction can be attributed to natural causes. The species characteristics that define the Columbia River salmon and steelhead make comparisons with other river systems problematic and unreliable. In addition, the cumulative effects of dam passage on spawning success are unknown.

As a result of these uncertainties, it is not possible to estimate the overall fish passage survival rates at the present time. However, taking into account natural mortality, which undoubtedly occurs, NMFS has determined that the current adult mortality resulting from project-related effects in the Mid-Columbia is likely no more than 2 percent for listed species.

3.2.8 SPECIES OF CONCERN

In addition to some of the Plan species, bull trout are also listed under the Endangered Species Act as threatened. Two other species (westslope cutthroat trout and river lamprey) are identified as Federal species of concern (WDFW 2002a). Other fish species expected to occur in the project are also listed as priority species or species of concern by the State of Washington (Table 3-6) (WDFW 2002a,b). Priority species classification indicates that the species requires protective measures and/or management guidelines to

TABLE 3-6. FISH SPECIES OF CONCERN AND PRIORITY SPECIES OCCURRING OR POTENTIALLY OCCURRING IN THE MID-COLUMBIA PROJECT AREA AND ASSOCIATED TRIBUTARIES

				Oc	CURRENCE	Ē	
	FEDERAL STATUS ¹	STATE STATUS ²	PROJECT AREA	WENATCHEE	ENTIAT	M ETHOW	OKANOGAN
Upper Columbia Spring- run Chinook Salmon (Oncorhynchus tshawytscha)	E	С	Yes	Yes	Yes	Yes	No
Upper Columbia Steelhead (Oncorhynchus mykiss)	E	С	Yes	Yes	Yes	Yes	Yes
Bull Trout (Salvelinus confluentus)	Т	С	Yes	Yes	Yes	Yes	Yes
Dolly Varden (Salvelinus malma)	None	С	Yes	Yes	Yes	Yes	Yes
Coho Salmon (Oncorhynchus kisutch)	None	M	Yes ³				
Westslope Cutthroat Trout (Oncorhynchus clarki lewisi)	SC	None	Yes	Yes	Yes	Yes	Yes
Kokanee (Oncorhynchus nerka)	None	М	Yes	Yes	No	No	Yes
White Sturgeon (Acipenser transmontanus)	None	M	Yes	No	No	No	Yes
Pacific Lamprey (Entosphenus tridentatus)	None	C	Yes	Yes	Yes	Yes	Yes
River Lamprey (Lampetra ayresi)	SC	С	Yes ³				
Lake Chub (Couesius plumbeus)	None	С	Yes	Yes	Yes	Yes	Yes
Leopard Dace (Rhinichthys falcatus)	None	С	Yes	No	No	No	No
Mountain Sucker (Catostomus platyrhynchus)	None	С	Yes	Yes	Yes	Yes	Yes
Pigmy Whitefish (Prosopium coulteri)	None	S	Yes	Yes	Yes	Yes	Yes
Channel Catfish (Ictalurus punctatus)	None	M	Yes	No	No	No	Yes
Largemouth Bass (Micropterus salmoides)	None	M	Yes	No	No	No	Yes
Smallmouth Bass (Micropterus dolomieui)	None	M	Yes	No	No	No	Yes
Walleye (Stizostedion vitreum)	None	M	Yes	No	No	No	Yes

¹ Federal status: E= Federally listed as endangered, T = Federally listed as threatened, SC = species of concern.

² State status: S = State listed as sensitive, C = candidate for State listing, M = State listed as priority species with recreational, commercial, and/or Tribal importance.

³ Native species, although there is no evidence of self-sustaining populations occurring in the basin.

ensure their perpetuation. They are of concern due to their population status and sensitivity to habitat alterations.

3.2.8.1 Life Histories

Bull Trout/Dolly Varden

Although Dolly Varden (Salvelinus malma) is currently distinguished as a distinctly separate species from bull trout (Salvelinus confluentus), they were considered to be the same species until the late 1970s. The Columbia River bull trout populations were listed as threatened under the Endangered Species Act in June 1998 (USFWS 1998), while Dolly Varden populations were not included in this listing. Bull trout are also a candidate species for listing as threatened or endangered in Washington State (WDFW 2002a). These closely related char species are difficult to distinguish in the field and have similar if not identical life histories (Mongillo 1993). Therefore, the following discussion of bull trout is generally applicable to Dolly Varden.

Eight potential bull trout subpopulations have been identified in the Wenatchee, Entiat, and Methow Rivers, while they are thought to be extirpated from the Okanogan River. However, bull trout were likely never abundant in the mainstem Columbia River (Mongillo 1993). Factors identified in the decline of bull trout populations in the area include dams, forest management practices, livestock grazing, agricultural water diversions, roads, and mining (Beschta et al. 1987). In addition, poaching and the presence of non-native fish species are adversely impacting bull trout populations (Mongillo 1993). Brook trout may have completely replaced bull trout in South Fork Beaver Creek, a tributary of the Methow River.

Four general forms of bull trout are recognized (anadromous, lacustrine, fluvial, and resident), each exhibiting a specific behavioral or lifehistory strategy (Brown 1992a; Pratt 1992).

Anadromous bull trout are typically found in coastal and Puget Sound river drainages, yet are extinct in the Mid-Columbia River region (Nehlsen et al. 1991). The lacustrine (adfluvial) form matures in lakes or reservoirs and spawns in tributaries, where the young reside for 1 to 3 years. Fluvial bull trout have a similar life history, except that they move between the Columbia River mainstem and smaller tributaries.

The lacustrine and fluvial bull trout are of the most concern in the Mid-Columbia River tributaries (Brown 1992a), as their habitat has been degraded more than that for resident forms. The stream resident bull trout spend their entire lives in smaller, high-elevation streams, apparently moving very little, and seldom reaching a size larger than about 12 inches (Brown 1994). Resident trout may have extensive seasonal movements or change lifehistory strategies (from resident to lacustrine) depending upon the current environmental conditions. This phenomenon may occur commonly for populations near Lake Wenatchee, where resident bull trout may migrate to the lake when stream flows (and attendant water temperatures) become intolerable. Habitat alterations that disrupt this capability to transmute may limit the population's stability.

Approximately 60 percent of the bull trout spawning and rearing habitat in the Methow River has been lost due to irrigation water withdrawals (USFWS 1998). Habitat degradation in the mainstem Entiat River from development and forest fires has severely depressed the densities of bull trout populations. Physical habitat problems are the most common detriment to bull trout populations, followed by flow and water quality problems. Bull trout are known for their need for cold pristine headwater areas during critical spawning and early life-history stages (Mongillo 1993). Thus, project operations do not affect spawning success, although the role of the projects on isolating populations and their genetic fitness is unknown.

Bull trout are occasionally observed in the adult and juvenile fish passage facilities of the Mid-Columbia River dams, although the information is limited. Although bull trout have been enumerated by fish counters stationed at the viewing windows of the fishladders during the adult salmon passage periods, counts prior to 1998 typically did not differentiate them from other trout. A total of 83 bull trout were counted passing Rocky Reach Dam between May 3 and July 31, 1998 (Chelan County PUD 2002 unpublished data). In 1999, 2000, and 2001, bull trout counts between May and July were 93, 183, and 176 fish at Rocky Reach Dam, respectively. In these years, the majority of the bull trout passed the project in May and June (75 to 90 percent). Although the extent of bull trout passage at other times of the year is generally unknown, some fish have been observed to pass Rocky Reach Dam in October and November.

Fewer bull trout were counted at Rock Island Dam than at Rocky Reach Dam in 1998, 1999, and 2000. Between 56 and 83 bull trout were counted passing Rock Island Dam in these years (Chelan County PUD 2002 unpublished data). In addition, the passage timing appears to be less compressed than at Rocky Reach Dam, with only 55 to 70 percent of the counts occurring in May and June.

Bull trout passage through the Wells Dam fishladders was recorded primarily during springrun chinook salmon broodstock trapping operations in 1998 and 1999. In 1998, trapping occurred one day a week between May 9 and July 1, resulting in 16 bull trout encounters (Douglas County 2002 unpublished data). Thirteen (81 percent) of these encounters occurred in June. In 1999, trapping occurred continuously between April 28 and June 9, and resulted in 47 bull trout encounters. Two additional bull trout were encountered during the two other days of trapping in 1999. Despite the limited number of trapping events in June (10 days), 65 percent of the bull trout encounters occurred during that month. Daily counts are available at Wells Dam in 2000

and 2001. These data indicated that at least 95 percent of the bull trout passed the project in May and June.

To gather additional information on bull trout migratory behavior in the Mid-Columbia River region, a 2-year radio-tagging study began in 2001 (BioAnalysts, Inc. 2002). A total of 39 bull trout were tagged in 2001 (7 fish at Rock Island, 22 fish at Rocky Reach, and 10 fish at Wells). Three of the bull trout tagged at Rock Island were released downstream of the dam and the other four fish were released upstream. At the other two projects, half of the fish were released upstream of the dam and the other half were released downstream. With the exception of one fish that died in the Rock Island pool, all of the tagged fish migrated to the Wenatchee, Entiat, or Methow Rivers for fall or fall/winter residence.

Of the seven fish released at Rock Island Dam, two entered the Wenatchee River, two migrated upstream to the Entiat River, two to the Methow River, and one died. None of these fish fell back below the dam.

Six of the fish tagged and released downstream of Rocky Reach Dam migrated downstream and entered the Wenatchee River, where they resided throughout the fall and winter. The other five bull trout migrated upstream, with four fish entering the Entiat River and one entering the Methow River. Similarly, 8 of the 11 bull trout released above Rocky Reach entered the Entiat system, and 3 migrated past Wells Dam to the Methow River. None of the fish that passed Rocky Reach Dam fell back below the project.

Nine of the ten fish released at Wells Dam migrated upstream to the Methow River, while one of the trout released downstream of the dam migrated downstream and entered the Entiat River. As with the other projects, none of the fish that passed Wells Dam fell back below the project.

Although bull trout tended to spend greater time passing each of the Mid-Columbia River hydroelectric projects, travel time through the reservoirs was similar to anadromous salmonids (English et al. 1998c, 1999). Although the fish spent time residing in the tailraces and fish ladders, once the fish began to migrate, they did so rather rapidly and all of the tagged fish appeared to enter tributary streams in time to spawn. As a result, there are no indications that dam operations negatively affected the survival of these fish.

Overall, the radio-tagged bull trout exhibited a wide range of behavior, relative to reservoir and tributary residence. Five of the eight trout that entered the Wenatchee River entered by the end of June, while the other two fish remained in the Columbia River for nearly 2 and 3 months longer. Four of the fish remained in the Wenatchee mainstem, while the others moved into smaller tributaries. Five of the tagged fish remained in the Wenatchee River watershed throughout the fall and winter, while the other three fish moved back to the Columbia River between November and December.

In contrast to the Wenatchee River fish, all 15 of the fish that entered the Entiat River did so by mid-July. Seven of these fish remained in the Entiat River mainstem, while the others moved up into the Mad River drainage. The fish that resided in the mainstem exited the Entiat River by mid-November, while the others remained in the Mad River throughout the fall and winter.

All 15 of the Methow River fish entered the river by mid-June, with four residing in the mainstem and the others moving upstream into the Twisp River drainage. Unlike the fish that entered the Entiat River, those that resided in the mainstem remained there through the winter, while four of the fish that entered the Twisp River left the Methow River Basin by mid-December.

As of May 2002, of the 15 fish that returned to the Columbia River, two fish were located

downstream of Rock Island Dam, seven fish between Rock Island and Rocky Reach dams, three fish between Rocky Reach and Wells dams, and three fish above Wells Dam.

These data indicate that some bull trout spend considerable periods of time rearing in the mainstem reservoirs and pass upstream through the adult fishladders to enter tributary areas, and some pass back downstream through the dams after exiting the tributary areas. Although it is not known how these downstream migrants pass the projects, there is no evidence of mortality based on the data to date. As a result, bull trout are subject to impacts from the operation of the projects, although little evidence is available to estimate the magnitude or nature of these impacts. Additional radio-tagging studies are being conducted to evaluate bull trout migration and rearing behavior in the project area.

The second year of this evaluation will provide additional information concerning the behavior of these fish, as well as additional fish tagged in 2002. The preliminary data indicate that some bull trout reside in the mainstem Columbia River for considerable periods of time, and undergo relatively lengthy migrations. However, it is unknown how the low water conditions in 2001 may have influenced their behavior.

Westslope Cutthroat Trout

Westslope cutthroat trout (*O. clarki lewisi*) is a priority species (WDFW 2002b). They are allopatric with rainbow trout and have similar life histories. They are chiefly distributed in upper reaches of east slope Cascade range tributaries (including the Wenatchee, Entiat, and Methow Rivers) and typically do not occur in the mainstem reservoirs. Many of these cutthroat trout show some degree of hybridization with rainbow trout. Westslope cutthroat trout exhibit adfluvial and fluvial life-history strategies. Their habitat requirements are similar to those of both rainbow trout and bull trout (Behnke 1992). Cutthroat and rainbow trout spawn at the same

time and place, and considerable hybridization results when hatchery-produced rainbow trout are stocked in streams with natural cutthroat trout (Simpson and Wallace 1982).

River Lamprey

River lamprey (*Lampetra ayresi*) is a Federal species of concern and a candidate species for listing by the State of Washington (WDFW 2002a). It is one of three species of lamprey that occur in the Columbia River Basin. The other two species are Pacific lamprey and western brook lamprey. River lamprey and Pacific lamprey exhibit parasitic life cycles, while the western brook lamprey completes its life cycle in freshwater and is nonparasitic (Close et al. 1995). River lamprey occur in coastal streams from northern California to northern British Columbia. Little is known about the biological or life-history characteristics of this species, although they are expected to be similar to those described for Pacific lamprey. Differentiation between these two species typically does not appear in historical information about the basin, with most observations and occurrences attributed to Pacific lamprey (BioAnalysts 2000a).

Pacific Lamprey

Pacific lamprey (*Entosphenus tridentata*) is a Federal species of concern (WDFW 2002a) that occurs in most tributaries to the Columbia River and in the mainstem Columbia River during their migration stages. They have cultural, utilitarian, and ecological significance in the basin since Indian Tribes have historically harvested them for subsistence, ceremonial, and medicinal purposes (BioAnalysts 2000a; Close et al. 2002). As an anadromous species, they also contribute marinederived nutrients to the basin.

Little specific information is known, however, on the life history or status of lamprey in the Mid-Columbia River watersheds. They are known to occur in the Wenatchee, Entiat, and Methow Rivers, although there are no indications that they currently use the Okanogan system (BioAnalysts 2000a).

In general, the adults are parasitic on fish in the Pacific Ocean, while the ammocoetes (larvae) are filter feeders that inhabit the fine silt deposits in backwaters and quiet eddies of streams (Wydoski and Whitney 1979). Adults generally spawn in low-gradient stream reaches in the tail areas of pools and in riffles, over gravel substrate (Jackson et al. 1996). Adults die after spawning. After hatching, the ammocoetes burrow into soft substrate for an extended larval period filtering particulate matter from the water column (Meeuwig et al. 2002). The ammocoetes undergo a metamorphosis, between 3 and 7 years after hatching, and migrate from their parent streams to the ocean from March to July, peaking in April. It is not known how long Pacific lamprey live in freshwater prior to migration, but it is assumed to be 5 to 6 years (Wydoski and Whitney 1979).

Due to the lack of information on lamprey habitat requirements, population sizes, and community structures, relatively little is known about the status of Pacific lamprey stocks in the Columbia River. However, estimates of adult Pacific lamprey passing Rock Island Dam in 1996 and 1997 totaled 2,121 and 2,321 fish, respectively (Jackson et al. 1996, 1997). Passage estimates at Rocky Reach were 593 and 1,405 fish in those same years, while at Wells Dam the estimates were 979 and 773 fish, respectively. However, these counts, as well as the comparison counts between the dams, are problematic because of sampling inconsistencies; the behavior of lamprey allows them to pass by certain types of counting stations without being counted (BioAnalysts 2000a). Peak passage in those years occurred between August and September.

Kokanee

Kokanee (*O. nerka*) is a Washington State priority species (WDFW 2002b) that occurs in Lake Wenatchee and Osoyoos Lake and

throughout the mainstem Columbia River. They are a landlocked or resident component of sockeye salmon. As a result, they have a similar life history (see Section 3.2.2.1, Life History), except that the adults remain in freshwater throughout their life cycle (Wydoski and Whitney 1979).

Pygmy Whitefish

Pygmy whitefish (*Prosopium coulteri*) is listed as a Washington State sensitive species, indicating that they are vulnerable or declining and likely to become endangered or threatened without cooperative management or removal of threats (WDFW 2002a). Pygmy whitefish are a native species, currently found in relic populations in western North America. The only known population in the project area is in Lake Chelan (Hallock and Mongillo 1998). This species inhabits lakes, typically staying deeper than 18 feet. They also reside in streams, preferring habitats with moderate to swift current. Little is known about the pygmy whitefish populations in the Mid-Columbia River region.

White Sturgeon

White sturgeon (Acipenser transmontanus) is a Washington State priority species with recreational, commercial, and/or Tribal importance (WDFW 2002b). They are a longlived, primitive fish species that forage primarily along the river bottom of large river systems in the Pacific Northwest. Prior to hydroelectric development in the Columbia River, the native anadromous white sturgeon could distribute downstream to feed in the rich estuary or marine areas before migrating back upstream to spawn. This anadromous life history is currently restricted in the upper river because they do not readily pass through the Columbia River fishladders. They are currently found throughout the basin and are thought to be successfully reproducing in some of the impoundments (Setter and Brannon 1992).

Commercial and sport harvest has resulted in depressing the population in the river, and their recovery is substantially limited by the isolation of segment populations by the hydroelectric dams.

Male sturgeon may mature at 10 to 12 years of age, while females may not mature until 15 to 32 years of age. Spawning occurs between February and July, depending on water temperature; most spawning occurs when water temperatures are 50° to 63° F (10° to 17° C) (Pacific States Marine Fisheries Commission 1992). Sturgeon spawn in swift currents (2 to 9 feet per second over cobble, boulder, and bedrock substrates) (Parsley and Beckman 1994), similar to those occurring in the tailrace areas throughout the Mid-Columbia River. Eggs and sperm are broadcast in fast-moving water, allowing the adhesive eggs to disperse before settling to the bottom. The eggs remain adhesive for less than 3 hours to allow additional time for fertilization.

Incubation occurs in 7 to 14 days, depending on water temperature. The hatched larvae are planktonic and drift downstream. Sturgeon are opportunistic feeders that prey on benthic organisms as juveniles, and a variety of benthicoriented prey as adults (including lamprey and fish).

DeVore et al. (1999) reported that white sturgeon are currently not abundant in the Mid-Columbia River. They captured only four sturgeon in 95 overnight longline sets in Rock Island reservoir. Sampling in Rocky Reach reservoir yielded 4.3 fish in 1,000 longline fishing hours (Chelan County PUD 2000).

Lake Chub

Lake chub (*Couesius plumbeus*) is a native species to the Columbia River and a candidate for listing as threatened or endangered by WDFW (WDFW 2002a). They inhabit a variety of habitats in both lakes and streams, with lake populations reported to migrate into tributary

streams to spawn (Wydoski and Whitney 1979). There is little information about lake chub in the project area, although they are infrequently captured in the mainstem reservoirs (Parametrix and University of Idaho 2000; BioAnalysts 2000b).

Leopard Dace

Leopard dace (*Rhinichthys falcatus*) is a native species to the Columbia River and a candidate for listing as threatened or endangered by WDFW (WDFW 2002a). They usually occur near or on the bottom in relatively shallow (typically less than 3 feet) and slow-moving habitats (less than 1.5 feet per second). Although they inhabit both lake and streams habitats, they are believed to spawn in tributary streams similar to other dace (Wydoski and Whitney 1979). There is little information about leopard dace in the project area, although they are infrequently captured in the mainstem reservoirs (Parametrix and University of Idaho 2000).

Mountain Sucker

Mountain sucker (*Catostomus platyrhynchus*) is a native species to the Columbia River and a candidate for listing as threatened or endangered by WDFW (WDFW 2002a). They occur in the Upper Columbia River and its tributaries, and prefer clear, cold-water streams with sand, gravel, and boulder substrate (Wydoski and Whitney 1979). There is little information about mountain sucker in the project area, although they are infrequently captured in the mainstem reservoirs (Parametrix and University of Idaho 2000).

Smallmouth Bass

Smallmouth bass (*Micropterus dolomieui*) are a non-native game fish that have inhabited the Mid-Columbia River reach since at least the 1940s. They are listed as a priority species in Washington State because of their vulnerability to habitat loss or degradation and their recreational

importance (WDFW 2002a). Preferred habitat for this species includes rocky shoals, banks, or gravel bars. Adult smallmouth bass in the Mid-Columbia River are most abundant around the deltas of warmer tributary rivers. They are also abundant areas upstream of the Mid-Columbia River reach. The optimal temperature range for this species is from 70° to 81° F (21° to 27° C) (Wydoski and Whitney 1979), which is higher than the temperatures typically observed in the Mid-Columbia River reservoirs.

Ideal spawning temperatures for this species range from 60° to 65° F (15.5° to 18.5° C). Although such temperatures do not occur consistently in the Mid-Columbia River reservoirs until late summer, these temperatures are present in the Okanogan River and Lake Osoyoos. Smallmouth bass build and defend nests in sloughs and littoral areas with sand and gravel substrates. Such areas are generally lacking in the Mid-Columbia River system. It is believed that primary natural reproduction of smallmouth bass in the Mid-Columbia River occurs only in the free-flowing Hanford Reach below Priest Rapids Dam and in the Okanogan River.

Smallmouth bass were the second most abundant predator species captured in the Mid-Columbia River region during predator assessment sampling conducted in 1994, most frequently captured from forebay sampling sites (Burley and Poe 1994). Similar relative abundance estimates of smallmouth bass were observed in recent sampling programs in the Mid-Columbia River reservoir areas (Beak and Rensel Associates 1999; Parametrix and University of Idaho 2000; Duke 2001). They are a significant fish predator species in the Columbia River, and prey on juvenile salmonids. In the 1994 predator assessment, fish composed 87 percent of the smallmouth bass diet, with salmonids consisting of 11 percent of the prey fish.

Walleye

Walleye (*Stizostedion vitreum*) are a cool-water, piscivorous game fish believed to have moved downstream into the Mid-Columbia River reach from a population established for recreational fishing in Lake Roosevelt in the late 1950s (Zook 1983). However, they were the least abundant predator species captured in the Mid-Columbia River in 1994 (Burley and Poe 1994). They are listed as a priority species in Washington State because of their vulnerability to habitat loss or degradation and their recreational importance (WDFW 2002a).

Walleye occur throughout the mainstem reservoirs but are not typically found in the tributaries. Although suitable spawning habitat appears to be plentiful in the Mid-Columbia River, peak summer temperatures in this section of river are suboptimal and appear to restrict the recruitment of subyearling walleye to the yearling age class (Zook 1983). Recruitment of walleye into the Mid-Columbia River reservoirs is suspected to result from the entrainment of young fish through Grand Coulee Dam during spring run-off (Zook 1983).

Largemouth Bass

Largemouth bass (*Micropterus salmoides*) were widely introduced in Washington in the late 1800s (Wydoski and Whitney 1979). They are listed as a priority species in Washington State because of their vulnerability to habitat loss or degradation and their recreational importance (WDFW 2002a). They prefer clear water habitat with mud and sand substrates, which is best suited for aquatic vegetation production (Wydoski and Whitney 1979). Little is known about the populations in the project area, although they are infrequently captured (Beak and Rensel 1999; Duke 2001; Parametrix and University of Idaho 2000; Burley and Poe 1994).

Channel Catfish

Channel catfish (Ictalurus punctatus) is a nonnative species that is found most often in clear lakes, reservoirs, and streams. In streams, this species is usually found in moderate to swift currents over sand, gravel, and rubble substrate. However, little is known about the species' habitat preferences in lakes and reservoirs (Wydoski and Whitney 1979). Channel catfish are listed as a priority species in Washington State because of their vulnerability to habitat loss or degradation and their recreational importance (WDFW 2002a). Little is known about the populations in the project area, although they are infrequently captured (Duke 2001; Parametrix and University of Idaho 2000; Burley and Poe 1994). No catfish were captured in sampling conducted in the Wells Dam reservoir in 1999 (Beak and Rensel 1999).

3.2.9 OTHER RESIDENT FISH RESOURCES

Resident fish resources in the Mid-Columbia River have not been studied extensively, but some information on species composition and abundance is available (Table 3-7). Dell et al. (1975) report the most abundant resident fish species were northern pikeminnow (*Ptychocheilus oregonensis*), stickleback (*Gasterosteus aculeatus*), and suckers (*Catostomus* sp.). They also determined that whitefish and pumpkinseed (*Lepomis gibbosus*) were the most abundant resident game fish, although these two species accounted for less than 2 percent of the total 32,289 fish sampled.

Beak and Rensel (1999) reported suckers (*Catostomus* sp.) as the most abundant resident fish, captured in beach seining sampling, in the Wells Dam forebay (Lake Pateros). This species represented 41 percent of the beach seining catch and 46 percent of the underwater dive survey counts in 1998. Other abundant species in the beach seine catch were bluegill (*L. microchirus*) (32 percent), northern pikeminnow (10 percent), peamouth (6 percent), and carp (*Cyprinus carpio*)

OTHER FISH SPECIES THAT MAY OCCUR IN THE COLUMBIA RIVER SYSTEM **TABLE 3-7.**

SCIENTIFIC NAME	COMMON NAME	PRESENCE IN PLAN AREA	STATUS	REFERENCE
Entosphenus tridentata	Pacific lamprey	A, B, C	native, common	Wydoski and Whitney 1979
Lampetra ayresi	river lamprey	A, B, C	native, unknown	Wydoski and Whitney 1979
Acipenser transmontanus	white sturgeon	A, B, C	native, common	BPA et al. 1994b
Prosopium williamsoni	mountain whitefish	A, B, C	native, common	Dell et al. 1975; U.S. Army Corps of Engineers 1994
Prosopium coulteri	pygmy whitefish	A, B, C	native, rare	BPA et al. 1994b
Prosopium spp.	lake whitefish	A, B, C	native, uncommon	Wydoski and Whitney 1979
Salmo trutta	brown trout	A, B, C	introduced, rare	Wydoski and Whitney 1979
Oncorhynchus clarki	cutthroat trout	A, B, C	native, common	Wydoski and Whitney 1979
Oncorhynchus nerka	kokanee	A, B, C	native, common	Dell et al. 1975
Oncorhynchus mykiss	rainbow trout	A, B, C	native, common	Wydoski and Whitney 1979
Salvelinus fontinalis	eastem brook trout	A, B, C	introduced, rare	Wydoski and Whitney 1979
Salvelinus confluentus	bull trout	A, B, C	native, uncommon	Dell et al. 1975; Wydoski and Whitney 1979
Salvelinus namaycush	lake trout	A, C	introduced, rare	Wydoski and Whitney 1979
Cyprinus carpio	сагр	A, C	introduced, common	Dell et al. 1975; Wydoski and Whitney 1979
Tinca tinca	tench	A, C	introduced, uncommon	Dell et al. 1975; Wydoski and Whitney 1979
Acrochelius alutaceus	chiselmouth	A, B, C	native, abundant	Dell et al. 1975
Richardsonius balteatus	redside shiner	A, B, C	native, abundant	Dell et al. 1975; BPA et al. 1994b
Rhinichthys cataractae	longnose dace	മ	native, common	Wydoski and Whitney 1979
Rhinichthys falcatus	leopard dace	A, C	native, common	Wydoski and Whitney 1979
Rhinichthys osculus	speckled dace	80	native, common	Wydoski and Whitney 1979
Ptychochellus oregonesis	northem pikeminnow	A, B, C	native, abundant	Burley and Poe 1994
Mylocheilus caurinus	peamouth	A, B, C	native, common	Dell et al. 1975
Couesius plumbeus	lake chub	A, B, C	native, abundant	Wydoski and Whitney 1979
Catostomus catostomus	longnose sucker	A, B, C	native, common	Wydoski and Whitney 1979
Catostomus macrocheilus	largescale sucker	A, B, C	native, abundant	Wydoski and Whitney 1979
Catostomus platyrhynchus	mountain sucker	A, B, C	native, common	Wydoski and Whitney 1979
Catostomus columbianus	bridgelip sucker	A, B, C	native, abundant	Wydoski and Whitney 1979
Ictalurus punctatus	channel caffish	A, B, C	introduced, uncommon	Wydoski and Whitney 1979

OTHER FISH SPECIES THAT MAY OCCUR IN THE COLUMBIA RIVER SYSTEM (CONTINUED) **TABLE 3-7.**

SCIENTIFIC NAME	COMMON NAME	PRESENCE IN PLAN AREA	STATUS	REFERENCE
Amiurus nebulosus	brown builhead	A, B, C	introduced, uncommogan	Wydoski and Whitney 1979
Amiurus melas	black bullhead	A, B, C	introduced, uncommogn	Dell et al. 1975; BPA et al. 1994b
Lota lota	burbot	A, C	native, uncommorπ	Wydoski and Whitney 1979
Gasterosteus aculeatus	three-spine stickleback	A, C	native, common	BPA et al. 1994b; Wydoski and Whitney 1979
Percopsis transmontana	sandroller	A, C	native, rare	Wydoski and Whitney 1979
Micrtopterus salmoides	largemouth bass	A, C	introduced, uncomm.o∎n	Dell et al. 1975; Wydoski and Whitney 1979
Micrtopterus dolomieui	smallmouth bass	A, C	introduced, commo⊸n	Wydoski and Whitney 1979
Pomoxis nigromaclatus	black crappie	A, C	introduced, commo⊷n	Dell et al. 1975; BPA et al. 1994b
Pomoxis annularis	white crappie	A, C	introduced, commo⊸n	Wydoski and Whitney 1979
Lepomis macrochirus	pluegill	A, C	introduced, commo n	Beak and Rensel, 1999.
Lepomis gibbosus	pambkinseed	A, C	introduced, uncomm oun	Dell et al. 1975; BPA et al. 1994b
Stizostedion vitreum	walleye	A, C	introduced, commo n	Dell et al. 1975; Wydoski and Whitney 1979
Perca flavescens	yellow perch	A, C	introduced, commo n	Dell et al. 1975; Wydoski and Whitney 1979
Cottus confusus	shorthead sculpin	A, B, C	native, common	Wydoski and Whitney 1979
Cottus beldingi	Piute sculpin	A, B, C	native, common	Wydoski and Whitney 1979
Cottus rhotheus	torrent sculpin	A, B, C	native, common	Wydoski and Whitney 1979
Cottus cognatus	slimy sculpin	A, B, C	native, common	Wydoski and Whitney 1979
Cottus asper	prickly sculpin	A, B, C	native, rare	Wydoski and Whitney 1979
Cottus bairdi	mottled sculpin	A, B, C	native, common	Wydoski and Whitney 1979

A = Project Area B = Tributaries C = Columbia River System

(5 percent). Fifteen other species represented the remaining 7 percent of the total catch of 3,783 fish

Based on fishladder observations, Mullan et al. (1986) found that resident salmonids and white sturgeon were scarce, and that the fish community was dominated by stickleback, minnow (Cyprinidae), and suckers. Known life-history characteristics of the resident fish species in the Mid-Columbia River Basin are provided below. Little is known about the other mainstem Columbia River resident fish, and they are not expected to have substantial interactions with Plan species in the project area. These species include yellow perch (Perca flavescens), black crappie (Pomoxis nigromaculatus), bluegill, brown bullhead (Ictalurus nebulosus), black bullhead (I. melas), carp, goldfish (Carassius auratus), chiselmouth (Acrochelius alutaceus), sandroller (Percosis transmontanus), tench (Tinca tinca), various sucker species, speckled dace (Rhinichthys osculus), longnose dace (R. cataractae), redside shiner (Richardsonius balteatus), peamouth chub (Mylocheilus caurinus), and sculpin (Cottus sp.) (Wydoski and Whitney 1979).

Rainbow Trout

Rainbow trout is an inland (remains in freshwater) form of steelhead. However, some rainbow trout remain in freshwater for most of their life but undergo a physiological change to a smolt and migrate to the ocean late in life. In addition to the potential for rainbow trout to become anadromous, the progeny of steelhead are believed to have the potential to become resident rainbow (Peven 1990). Inland rainbow and juvenile steelhead are not distinguishable from each other until the steelhead undergo smoltification. The Mid-Columbia River tributaries contain a mixture of resident rainbow and ocean-migrating steelhead. The ability of the species to alternate life-history strategies is an

adaptive mechanism to variable environmental conditions.

Mountain Whitefish

Mountain whitefish are assumed to occur in all small-order tributaries to the Wenatchee, Entiat, Methow, and Okanogan Rivers, and in connecting larger lake systems. They are also believed to occur in the mainstem reservoirs, although their behavior patterns are not known. They mostly inhabit riffles in summer and large pools in winter (Wydoski and Whitney 1979). Spawning typically occurs from October through December, generally in riffles, but also on gravel shoals of lake shores. Mountain whitefish feed primarily on instar forms of benthic aquatic insects, although they also occasionally eat crayfish, freshwater shrimp, leeches, fish eggs, and small fish. In lakes, they feed extensively on zooplankton, particularly cladocerans. There is evidence that mountain whitefish historically spawned in lower reaches of some tributaries, but the mainstem hydroelectric dams inundated these habitats.

Northern Pikeminnow

Northern pikeminnow (formerly northern squawfish) are a slow-growing, long-lived predator. In summer, adult northern pikeminnow prefer shallow, low velocity areas in cool lakes or rivers. During the winter, they use deeper water and pools (Scott and Crossman 1973). Spawning occurs during the summer, in shallow water areas with gravel substrate.

Northern pikeminnow are the most abundant predator species in the Columbia River system, and accounts for over 75 percent of the total catch of predator fish in the Mid-Columbia River (Loch et al. 1994). They tend to concentrate in tailrace areas downstream of mainstem dams during the juvenile salmonid migration period, holding in relatively slow-moving water areas (less than about 3 feet per second) near passage routes.

They are also expected to occur in tributary streams where slow-moving water occurs.

Between 1994 and 2002, the predator abatement programs resulted in the removal of 52,611 northern pikeminnow at Wells Dam, 33,110 pikeminnow at Rock Island Dam, and 44,882 pikeminnow at Rocky Reach Dam (Douglas County PUD 1999; Chelan County PUD 1999c; Bickford 2002 personal communication). In addition, over 7,700 northern pikeminnow were removed during fishing derbies conducted between Rock Island and Chief Joseph dams from 1998 through 2001 (West 2002).

3.2.10 AQUATIC HABITAT

The mainstem hydroelectric projects throughout the Columbia River system have directly and indirectly resulted in substantial changes to the aquatic habitats. The most obvious direct effect was the change from a free-flowing river system to a series of reservoirs. This change resulted in the inundation of salmonid spawning and rearing habitat and the creation of habitat better suited to cool and warm-water fish species. These reservoir impoundments not only change the aquatic habitat in the immediate vicinity of the dams, but also change the seasonal flow and water temperature variations throughout the basin.

3.2.10.1 Reservoir Habitat

Reservoirs have increased water depth, surface area, and retention time, and decreased water-mixing processes compared to free-flowing rivers. These factors combine to increase overall water temperatures, as well as to promote temperature stratification in the deep reservoir areas. As a result, reservoir releases are typically cooler in the spring and summer and warmer in the fall and winter, compared to natural conditions. However, these factors are largely influenced by the large storage reservoirs upstream of the Mid-Columbia River projects.

The Mid-Columbia River projects are run-of-theriver facilities that have limited water storage or flow regulation capabilities (see Water Quality, Section 3.3.2).

The natural variation in seasonal flow is also highly modified in the Mid-Columbia River by the large upstream storage reservoirs associated with Chief Joseph, Grand Coulee, and other storage dams located in Canada that capture the spring run-off and release that water over an extended period. These yearly and seasonal changes to the natural aquatic environment have resulted in substantial changes to the aquatic ecosystem. The aquatic ecosystem consists of a sophisticated and delicate network of interrelationships between a wide range of biological organisms and habitats. Small changes in an ecosystem can have noticeable effects, although they might be isolated to a small number of organisms or habitat types.

One part of the aquatic ecosystem that is often particularly sensitive to changes in water quality is the benthic community. This community consists of a diverse assortment of plants and animals that grow or live on the bottom of lakes and rivers. Many of these organisms are sedentary or have limited mobility, so they are highly susceptible to environmental changes, such as fluctuations in water level or temperature. Benthic organisms are an essential part of the food chain on which resident and anadromous fish species depend. Other important food chain components include phytoplankton and zooplankton, which are tiny floating plants and animals.

Studies in the Lower Columbia River have shown that juvenile chinook salmon (both ocean- and stream-type) actively feed during their outmigration. These fish feed on aquatic insects in the spring, switch to zooplankton during July and September and back to aquatic insects in the fall (Craddock et al. 1976). Stream-type chinook salmon in the Lower Granite reservoir were found to feed primarily on Chironomidae, as well as

minor amounts of Cladocera, Ephemeroptera, Trichoptera, Plecoptera, and terrestrial insects (Chandler 1995 personal communication). Due to limited reach-specific data, it is assumed that feeding habits of juvenile fish are consistent with those observed elsewhere in the system.

Juvenile Passage Through Reservoirs

Reservoir impoundments can create increased rearing area and provide overwintering habitat for juvenile anadromous salmonids. It can also affect the outmigration of anadromous salmonid juveniles by causing extended travel times and decreased survival rates. The use of the term "extended travel times" refers to slower rates of travel by outmigrating juvenile anadromous salmonids. Juveniles, when exposed to extended travel times and increased water temperatures, can residualize (become residents) and fail to migrate to the ocean (NMFS et al. 1998a). Juvenile fall-run chinook salmon now migrate up to 4 weeks later than they did before the development of the Hells Canyon Complex and the four Lower Snake River projects. This is suspected to be caused by increased incubation time and slower growth rates during the early rearing life stage due to cooler than historic water temperature, as well as potential delays in adult spawning due to warmer water temperatures during that period (NMFS 2000d).

Raymond (1968, 1969, 1979) and Bently and Raymond (1976) estimated that juvenile anadromous salmonids move through the Snake River and Lower Columbia River impoundments one-half to one-third slower than they would through free-flowing river sections of the same length. According to Raymond (1979), juvenile steelhead and chinook salmon migrate through free-flowing stretches of river at 14 miles per day, while they move through impounded waters at 5 miles per day. Fielder and Peven (1986) found similar rates (3 to 6 miles per day) for stream- and ocean-type chinook salmon and steelhead juveniles in the Mid-Columbia River reservoirs.

Giorgi et al. (1997) reported the migration rates of PIT-tagged chinook salmon and steelhead smolts at 13.4 and 18.9 miles per day, respectively between Rock Island Dam and McNary Dam. This area includes the free-flowing Hanford Reach. By comparison, travel rates estimates for these same species (chinook salmon and steelhead) in the Snake River (with limited free-flowing reaches) were 4.6 and 8 miles per day (Rondorf and Banach 1996).

Increased migration times can affect the size and survival rate of juveniles, timing of ocean transition and thermal imprinting. Increased migration times can cause migrating juveniles, especially steelhead, to revert to parr (residualize). Laboratory evidence suggests that water temperatures in excess of 68° F (20° C) for about 20 days, or delaying migration beyond the end of June, may cause steelhead smolts to revert to parr (Chapman et al. 1994b; Adams et al. 1975; Wagner 1974; Zaugg 1981). Some reverted parr residualize and are lost to anadromous production.

Extended travel times due to passage through reservoirs also increase potential exposure of juvenile outmigrants to predatory fish and reduce migration survival. In addition to the increased exposure to predatory fish, Vigg and Burley (1991) reported that forage rates of piscivorous fish increase with increases in water temperature.

Sims and Ossiander (1981) reported stream-type chinook salmon and steelhead juvenile survival improved with increasing flow. While increasing flow may increase migration speed and associated reservoir survival through the Lower Columbia and Snake River impoundments, there is little evidence to suggest that increased flows will increase survival of spring-run chinook salmon in the Mid-Columbia River reach. However, there are some indications that survival of steelhead might be affected by flow (NMFS 1998; Chapman et al. 1994a).

Under existing conditions, water velocities in the Mid-Columbia River reach are typically greater than in the Snake and Lower Columbia River system. The increased water velocities also result in faster juvenile migrations through the Mid-Columbia River reach. However, the faster travel in the Mid-Columbia River reach does not appear to improve overall survival, thus, it is uncertain if increasing the travel rate by increasing flows will substantially change survival rates in the Mid-Columbia River (NMFS 1998). In view of the uncertain benefit of increases in travel rates, improving juvenile outmigrant survival in the Mid-Columbia River reach may best be achieved by predator control and improved dam passage conditions.

Adult Passage Through Reservoirs

There is little evidence to suggest that significant impacts on adult migration and pre-spawning mortality occur in the Mid-Columbia River project reservoirs. Bjornn and Peery (1992) included information from Mid-Columbia River and other run-of-the-river reservoirs in their comprehensive review of the effects of reservoirs on adult salmon and steelhead. Based on the available information, they concluded that run-ofthe-river reservoirs had minimal effect on migrating adults. Adult salmonids generally pass through these reservoirs at similar or faster rates than they do in the naturally flowing river. There is little evidence of disorientation, wandering, straying, or mortality associated with reservoir conditions.

Reservoir Habitat Use

Mainstem spawning and rearing habitat for anadromous salmonids in the Mid-Columbia River reach was inundated by the formation of five PUD reservoirs beginning at the Priest Rapids Dam and extending to the Chief Joseph Dam. The total surface area of the Columbia River between Priest Rapids and Chief Joseph dams doubled from 23,000 to 46,000 acres

following inundation by the dams (Mullan et al. 1986). Since upstream passage facilities were not provided when Chief Joseph Dam was constructed, Chief Joseph Dam is the upstream extent of mainstem anadromous salmonid production. Natural anadromous salmonid spawning in the mainstem Mid-Columbia River presently is limited primarily to the free-flowing Hanford Reach downstream of Priest Rapids Dam, and to the major tributaries including the Wenatchee, Chelan, Entiat, Methow, and Okanogan River systems. Some limited mainstem spawning also occurs in the upstream portions of the reservoirs in project tailrace areas where streambed hydraulics and substrate conditions allow (Carlson and Dell 1989, 1990, 1991, 1992; Dauble et al. 1994; Chapman et al. 1994a).

Whitefish, trout, and char were important resident species prior to reservoir inundation. The change from a free-flowing environment undoubtedly eliminated much of the spawning and rearing habitat of these resident salmonid fish populations. However, recent bull trout radiotagging studies indicate the some bull trout rear for considerable periods of time in the reservoirs (BioAnalysts, Inc. 2002). Under present conditions, few salmonids reside in the reservoir and their numbers probably represent less than 1 percent of the total fish numbers (Dell et al. 1975; Zook 1983; Mullan et al. 1986). Habitat alteration created a subsequent shift in species composition toward dominance by cool water non-game species. Non-game fish such as sucker, chub, pikeminnow, and shiners, comprise the majority of the reservoir resident fish population (BPA et al. 1994a,b).

Reservoir production concerns and issues are related to a reduction in fish habitat for spawning and juvenile rearing life-history stages. The factors affecting reservoir habitat for these life stages are discussed in the following sections.

Spawning Habitat

Existing mitigation for losses of mainstream spawning habitat due to inundation by the reservoirs is set forth in the existing FERC licenses for the projects. Additional concerns related to reservoir effects on the existing spawning sites include deposition of fine sediments that may reduce incubation and spawning success; scour and relocation of gravel near the tailrace of each dam.

Sediment Deposition and Gravel Scouring

Smoothing of the hydrograph and lack of significant flow velocities as a result of Columbia Basin hydroelectric development has increased the amount of fine sediment present in mainstem cobble substrate, especially in the lower portions of reservoirs (Falter et al. 1991). The Mid-Columbia River is not a navigational shipping corridor, so dredging is not required in the reservoirs. In addition, the turbine intakes at the dams extend to the bottom of the reservoirs, minimizing the sedimentation immediately behind the dams, and thereby eliminating the need for maintenance dredging.

Mainstem anadromous salmonid spawning is concentrated in dam tailrace areas, where conditions are most like a free-flowing river. River hydraulics in these areas are sufficient to maintain well-sorted substrates, relatively free of fine sediment, and velocities that meet spawning preferences of salmonids.

Columbia River mainstem tributaries have the potential to deposit bedload material into reservoirs, forming alluvial fans at the confluences. If the accumulation of fine sediment is not excessive, then bedload material could provide a good source of spawning substrate, as long as local water velocities are appropriate for spawning and they are sufficient to keep excessive levels of fine sediment from accumulating throughout the incubation stage. Fine sediment loading in the Okanogan Basin is

considered high, while the Methow and Wenatchee river systems transport a moderate level of fine sediment (Rensel Associates 1993).

To date, mainstem spawning in the tailrace areas has probably been increasing since the 1980s (Mullan 1987; Chelan County PUD 1991), although this apparent increase may be an artifact of researchers spending more time and effort looking for mainstem spawning. Such data indirectly suggest any gravel relocation in the tailraces has not adversely reduced spawning opportunities. Thus, tailrace hydraulic effects may be maintaining spawning opportunities in the reservoirs, particularly for summer- and fall-run chinook salmon (Chapman et al. 1994a).

Fluctuation of Pool Elevations

Maximum pool fluctuations in Mid-Columbia River reservoirs are generally less than 10 feet, although they occur primarily in winter (Zook 1983; Chapman et al. 1994a) during the period when chinook salmon embryos and alevins are incubating in the substrate. Water level fluctuations can have an adverse effect on embryos depending upon the degree and duration of the fluctuation and embryo development stage. Studies indicate prolonged periods of dewatering, up to 12 days, do not reduce embryo survival (Becker et al. 1983; Neitzel et al. 1983). After hatching, alevins can withstand only brief periods (1 to 2 hours) of dewatering without reductions in survival.

Reservoir spawning is suspected to occur in relatively deep mainstem waters near the upstream portions of the reservoirs. Giorgi (1992) and Rensel Associates (2000) observed chinook salmon spawning in the upper reaches of Rocky Reach reservoir and the Wells Dam tailrace at depths between 8 and 23 feet, with most redds constructed at depths greater than 20 feet. Because of the depth of these redds, they are not expected to be affected by water level fluctuations as a result of project operations. The Rocky Reach Dam has a 4-foot reservoir elevation operating range.

Spawning Locations

The importance of mainstem Columbia River reservoir spawning habitats varies by species and race/deme. There is no evidence of substantial mainstem spawning for spring-run chinook salmon, steelhead, sockeye, or bull trout in the Mid-Columbia River reservoirs. The following species-specific accounts focus on mainstem spawning conditions in the Mid-Columbia River Basin.

Ocean-Type Chinook Salmon

Summer/fall-run chinook salmon are known to spawn in the upstream portions of reservoirs, or tailrace areas, where stream velocities, substrate and inter-gravel flows are sufficient to support redd development and embryo incubation (Chapman et al. 1994a). However, the most significant fall-run chinook salmon spawning area in the Mid-Columbia River occurs downstream of Priest Rapids Dam in the free-flowing Hanford Reach (Carlson and Dell 1989; Chapman et al. 1994a). Currently, naturally spawning oceantype summer-run chinook salmon are also found in the Wenatchee, Okanogan, and Methow Rivers (Waknitz et al. 1995). Summer-run chinook salmon are also reported to spawn in the Lower Entiat and Chelan Rivers, in addition to below mainstem Columbia River dams (Marshall et al. 1995); however, it has not been determined whether or not these are self-sustaining populations.

Stream-Type Chinook Salmon

Stream-type (spring) chinook salmon spawning has not been observed in the reservoir areas, except at the mouths of tributary streams that are inundated by reservoir water. However, some potential spawning could occur in areas of substantial groundwater upwelling.

Sockeye Salmon

Sockeye salmon spawning in the Okanogan and Wenatchee Rivers has been documented during September to October (Mullan 1986). Limited spawning may occur in the Methow and Entiat Rivers maintaining remnant sockeye salmon

populations from previous introductions (Mullan 1986). Because of the necessity for juvenile lake rearing, sockeye salmon are not regarded as a mainstem spawner.

Steelhead

Summer-run steelhead spawning has not been observed in the reservoirs but some potential spawning could occur in areas of substantial groundwater upwelling. Past decisions regarding mitigation for steelhead spawning habitat have assumed that steelhead used the reservoirs (Chelan County PUD 1991). As a result, the effects of reservoir inundation on steelhead spawning production may be expected to be similar to that for summer/fall-run chinook salmon.

3.2.10.2 Project Area Rearing

Factors with the potential to affect the rearing capacity of reservoirs include habitat condition, flushing rate, aquatic productivity, level of submerged macrophyte growth, and water quality conditions. The potential effects of these factors on rearing habitat are discussed below.

Habitat Conditions

The Mid-Columbia River hydroelectric projects are operated as run-of-the-river facilities with reservoirs that have relatively rapid flushing rates and limited thermal stratification during summer. Most shorelines are steep with relatively little littoral area in comparison to their size. Rapid water exchange and relatively featureless shorelines limit juvenile anadromous salmonid rearing habitat. The majority of reservoir margins are undeveloped, and riparian habitat adjacent to the reservoir is sparse, characteristic of the dry land climate.

Reservoir Flushing and Turnover Rate

Water retention, or flushing rate, of reservoirs is a function of the total reservoir volume divided by inflow over a given period of time. The mean annual flushing rate of Mid-Columbia River reservoirs ranges between 0.6 and 5.6 days. Beak Consultants, Inc. and Rensel Associates (1999) reported mean flushing rates of 1.5 days in the Wells Dam reservoir and 1.8 days in the Rocky Reach reservoir. Such rapid flushing rates are primarily related to the shallow depths of the reservoirs. Average water velocity through the Mid-Columbia River reach is estimated to be 0.9 to 3.1 feet per second at river flows between 79,000 to 270,000 cfs (Chapman et al. 1994b). Reservoir flushing rate is an important consideration for aquatic productivity as discussed below.

Aquatic Productivity

Aquatic productivity is typically high in freeflowing sections of mainstem rivers. Dauble et al. (1980) found a diverse aquatic macroinvertebrate and zooplankton community in the Hanford Reach below Priest Rapids Dam. Reservoir inundation typically decreases productivity and diversity of benthic and limnetic organisms (Mullan 1986). The invertebrate community is dominated by chironomids, oligochaetes, and zooplankton (Falter et al. 1991). Thus, juvenile salmonids (which prefer large, high energy content food items [such as Trichoptera]) switch first to chironomids, then to zooplankton as abundance of the preferred food items decline (Rondorf and Gray 1987). Therefore, productivity may limit the feeding efficiency of juvenile anadromous salmonids, who must expend more energy to capture lower energy content prey in the reservoirs as compared to free-flowing reaches.

Most of the primary and secondary production potential in the Mid-Columbia River region is generated from upstream sources. Lake Roosevelt (upstream of Grand Coulee Dam) is the single most important factor influencing aquatic productivity in the downstream PUD reservoirs due to the slow turnover rate, large storage capacity and source of nutrients (Rensel Associates 1993). The thermal regime of the Mid-Columbia River is also influenced by

releases from Grand Coulee Dam. Lake Roosevelt exhibits strong thermal stratification during summer months. Since Grand Coulee Dam is not equipped with selective depthwithdrawal facilities, downstream water temperatures are heavily dependent on the depth of the Lake Roosevelt thermocline.

The flow-through characteristics of the Mid-Columbia River Dam reservoirs result in primary productivity being largely dependent on detritus, sessile (attached) algae, and macrophytes (Mullan 1986). The turnover time of water in the pool is too short in summer to permit development of extensive and diverse zooplankton communities.

Submerged Macrophytes

Submergent aquatic plants are increasing in some of the Mid-Columbia River reservoirs. The benthic community in these submerged macrophyte beds is similarly increasing as riverine macrophytes effectively create substrate by velocity reduction and subsequent particle trapping, encouraging settling of organic-rich soils (Falter et al. 1991). Macrophyte beds eventually increase the production of benthic food organisms, as well as providing additional surface area for algae and invertebrates. They may also provide cover for rearing juvenile anadromous salmonids and other fish species.

The dominant species within the aquatic plant communities in the Mid-Columbia PUD reservoirs (Truscott 1991) is non-native Eurasian water milfoil (*Myriophyllum spicatum*), which forms large, dense monotypic beds with a relatively low volume to edge ratio. These conditions may not provide as much cover and rearing opportunities as native plants, but they still offer substantial shallow water rearing habitat. Only under very dense conditions, would milfoil act to reduce the productive capacity of aquatic habitats.

Given the steep bathymetry of the reservoirs, it is not likely that the density of submerged macrophytes would become a problem for fish rearing. Therefore, it is reasonable to conclude that continued development of macrophyte beds in the reservoirs should improve aquatic productivity in the reservoir and benefit shallow water fish rearing.

Fish Stranding Potential

Many small fish, including chinook salmon fry, use shallow water habitat and embayments along the reservoir shoreline. Trenches or depressions in the river bottom can form isolated pools at low reservoir levels. Juvenile fish trapped in such pools can perish from desiccation, if the pool drains as water moves through the substrate, or from increased predation. However, Mid-Columbia River reservoirs generally consist of steep morphologies along the river margins and have very little backwater or shallow areas (Zook 1983) thereby reducing the potential for stranding juvenile fish.

Coordination within the Mid-Columbia River hydroelectric system strives to hold all reservoirs as close to full as possible to optimize gross head and total generation (Mid-Columbia Hourly Coordination Agreement). Flow reductions following evening peaking may create rapid decreases immediately downstream of the projects. However, Mid-Columbia River reservoirs typically encroach on the tailraces of upstream dams, which moderates elevation fluctuations in the tailrace and reduces the potential to strand juvenile fish.

Water Quality

Water quality in the Mid-Columbia River reach is influenced by the operation of Grand Coulee Dam; the Mid-Columbia PUD projects have limited capability for flow regulation. Dissolved oxygen is adequate in all reaches, with exception of some extreme backwaters where aquatic weed growth restricts water flow. Turbidity is generally very low in the reservoirs (Rensel Associates 1993). However, spilling water at the projects increases the total dissolved gas levels that can cause gas bubble disease in fish and other aquatic organisms. Additional information

regarding water quality in the Mid-Columbia River reach is found in Section 3.3.2, Water Quality.

Project Area Rearing

The importance of mainstem Columbia River reservoir habitat for rearing juvenile anadromous salmonids varies by species and race/deme. Stream-type (spring) chinook salmon, steelhead and sockeye salmon do not appear to use the shoreline habitats of the mainstem Columbia River, but outmigrate in the mid-channel areas of reservoirs (Burley and Poe 1994; Dauble et al. 1989). The river is regarded as a migration corridor in which food may be encountered. Limnetic zooplankton and drift may be a primary food source of yearling outmigrants (Burley and Poe 1994). Ocean-type chinook salmon spend relatively long periods of time feeding and rearing in the mainstem Columbia River reservoirs (Chapman et al. 1994a).

Spring-Run Chinook Salmon

Spring-run chinook salmon utilize the mainstem Columbia River primarily as a migration corridor. As a result, they spend little time rearing in the Mid-Columbia River reservoirs (Chapman et al. 1995a).

Ocean-type (Summer/Fall-Run) Chinook Salmon

Ocean-type (summer/fall) chinook salmon juveniles use the mainstem reservoirs for rearing in late spring and early summer (Chapman et al. 1994a; Burley and Poe 1994). Recently emerged ocean-type chinook salmon juveniles rear throughout the shallow, low-velocity areas of the reservoirs in April and May. After reaching approximately 2 inches in size, they move slightly offshore into faster flowing water (Chapman et al. 1994a). Chinook salmon might feed on limnetic species when available, but prefer benthic macroinvertebrates in the drift when rearing (Chapman et al. 1994a). Based on these criteria, it appears that most suitable chinook salmon rearing habitat is found in the upstream portions

of the reservoirs, where river velocities are greater and the substrates are coarser (less fine sediment) than downstream in the reservoirs. However, no surveys have been done in the Mid-Columbia River reservoirs to verify habitat preferences and rearing areas of ocean-type chinook salmon.

Summer-Run Steelhead

Ninety percent of the steelhead production upstream of the Priest Rapids project occurs in hatcheries (Chapman et al. 1994b). The balance of the production occurs in the tributaries, although some minor amount of reservoir rearing may occur during overwintering periods. Although steelhead feed in the reservoirs during their seaward migration, the reservoirs serve primarily as migration corridors rather than as rearing habitat (Chapman et al. 1994b).

Sockeye Salmon

Although sockeye salmon could conceivably rear in the reservoirs, the rapid flushing rate, low primary productivity and lack of abundant zooplankton limit production potential. The Wells Dam reservoir may be a source of rearing habitat for the small but sustained run of Methow River sockeye salmon (Bickford 1994; Chapman et al. 1995b), and the Rocky Reach pool for the remnant run of Entiat River sockeye salmon (Mullan 1986; Chapman et al. 1995b).

Predation

Construction of hydropower facilities on the Mid-Columbia River has created impoundments with habitat more conducive to predators compared to the pre-impounded free flowing river. Changes in physical habitat, water quality, and downstream passage conditions have combined to increase the risk of juvenile outmigrant mortality due to predation (Mullan et al. 1986; Chapman et al. 1994b). Dams present an obstacle to the downstream migration of juvenile anadromous salmonids, often causing them to concentrate in forebays before finding a route past the dam.

Concentrations of juvenile anadromous salmonids provide a ready food supply for predators that congregate at such sites (Beamesderfer and Rieman 1991). Passage through turbines, spillways, or bypass facilities may stun, disorient, or injure some juvenile anadromous salmonids, making them less capable of escaping predators. Sediment that formerly would have been suspended during high spring flows settles out in upstream impoundments, resulting in reduced turbidity in the Mid-Columbia River. Clearer water makes juvenile outmigrants potentially more visible and more susceptible to predation.

In addition to juvenile outmigrants being more susceptible to predators (fish and avian) while migrating past the dams, the number of predators is presumed to have increased to levels greater than pre-impoundment conditions in the Mid-Columbia River reach. The following sections provide a general background description of predation (fish and avian) in the Mid-Columbia River reach, and they identify potential methods for reducing predation on juvenile anadromous salmonids.

Piscivorous Fish

The deep, low velocity habitat created by impoundments is preferred by northern pikeminnow, the major native predator fish of juvenile anadromous salmonids. Two other game fish species, walleye and smallmouth bass, were introduced into the Columbia River system in the 1940s to 1950s to provide sport-fishing opportunities (Zook 1983). These piscivorous game fish have become established in the Mid-Columbia River reservoirs, and prey on juvenile anadromous salmonid outmigrants.

In the Columbia River Basin, a predator indexing approach is used to estimate the magnitude of predation on juvenile salmonids by piscivorous fish (Vigg and Burley 1990). Modeling results indicate that piscivorous fish consume up to 19 percent of all juvenile salmonids migrating through the John Day reservoir, and up to 61 percent of ocean-type chinook salmon (Riemen et

al. 1991). Because of their abundance and high consumption indices, northern pikeminnow are the most significant predator, accounting for approximately 78 percent of juvenile salmonids lost to predation by fish. Introduced predator species, such as smallmouth bass and walleye, accounted for the remainder of the losses.

NMFS (2000e) summarized the best available scientific information regarding predation on anadromous salmonids as it relates to the existence and current operation of the Federal hydroelectric projects on the lower Snake and Columbia Rivers. NMFS believes that this information is also generally applicable to the Mid-Columbia River projects.

Northern Pikeminnow

The northern pikeminnow is a slow-growing, long-lived predator. In summer, adult northern pikeminnow prefer shallow, low velocity areas in cool lakes or rivers. During the winter, they use deeper water and pools (Scott and Crossman 1973). Northern pikeminnow pose the greatest predation threat to migrating juvenile anadromous salmonids in the Columbia River system because of their number and distribution. Northern pikeminnow accounted for over 75 percent of the total catch of predator fish in the Mid-Columbia River (Loch et al. 1994).

Juvenile salmonids are not a major prey species for northern pikeminnow in riverine environments under natural conditions because they prefer slack water habitat that is limited in the unimpounded areas of the Mid-Columbia River region (Brown and Moyle 1981). A study in the free-flowing portion of the Willamette River found that only 2 percent of the northern pikeminnow stomachs sampled contained juvenile salmonids, despite the fact that sampling took place during the peak juvenile salmonid outmigration (Buchanan et al. 1981).

Because of the concentrations of prey and favorable hydraulic conditions, areas adjacent to and downstream of tailraces have become preferred feeding habitat of northern pikeminnow. The gut contents of northern pikeminnow collected from the tailrace sampling areas at all of the Mid-Columbia River projects contain a higher proportion of juvenile salmonids than pikeminnow collected in the forebays or midreservoirs of the same projects (Sauter et al. 1994). In a study conducted in the John Day reservoir from 1983 to 1986, juvenile salmonids accounted for 21 percent of the diet of northern pikeminnow less than 12 inches in length and 83 percent of the diet of larger pikeminnow (Poe et al. 1991). The length of juvenile salmonids consumed by northern pikeminnow also increases progressively with the length of the pikeminnow.

Predation by northern pikeminnow results in substantial losses of juvenile salmonids in the Columbia River system each year. Estimated losses of between 1.9 and 3.3 million juvenile salmonids were estimated in the John Day reservoir alone between 1983 and 1986 (NMFS 2000e). At that time, the estimated northern pikeminnow population in the reservoir was about 85,000 fish. However, the reduction in overall predation, as a result of the removal of northern pikeminnow through predator control programs throughout the system is estimated at between 13 and 15 percent (NMFS 2000e).

Smallmouth Bass

Smallmouth bass are a game fish that have inhabited the Mid-Columbia River reach since at least the 1940s. Preferred habitat for this species includes rocky shoals, banks, or gravel bars. Adult smallmouth bass in the Mid-Columbia River are most abundant around the deltas of warmer tributary rivers.

In a 1993 survey of the Mid-Columbia River system conducted by the National Biological Survey and the WDFW, smallmouth bass were the second most abundant predator species captured, but accounted for only 9 percent of the total catch (Sauter et al. 1994). The majority of the bass were taken from the reservoir forebays, and the fewest from the tailraces (Burley and Poe

1994). The overall abundance of smallmouth bass in the Mid-Columbia River system appears to be low (Duke 2001; Parametrix and University of Idaho 2000). In addition, smallmouth bass tend to have a low predation rate on salmonids (NMFS 2000e).

The preference of smallmouth bass for low velocity shoreline areas in the Mid-Columbia River reservoirs may reduce their predation on some juvenile salmonid outmigrants. While juvenile stream-type salmonid outmigrants move through the mid-reservoir areas and may avoid substantial interactions with smallmouth bass, juvenile ocean-type salmonid migrants use the shoreline areas and may be an important prey item for smallmouth bass (Poe et al. 1991).

Walleye

Walleye are a cool water, piscivorous game fish believed to have moved downstream into the Mid-Columbia River reach from a population established for recreational fishing in Lake Roosevelt in the late 1950s (Zook 1983). Although suitable spawning habitat appears to be plentiful in the Mid-Columbia River, evidence of successful reproduction has not been observed (Zook 1983). Recruitment of walleye into the Mid-Columbia River reservoirs is suspected to result from the entrainment of young fish through Grand Coulee Dam during spring run-off (Zook 1983).

Walleye were the least abundant predator encountered in the 1993 National Biological Survey investigation in the Mid-Columbia River, accounting for only 4 percent of all predators caught (Burley and Poe 1994). Of the walleye captured during this survey, 89 percent were caught from dam tailraces, while the remaining 11 percent were caught in mid-reservoir and forebays (Loch et al. 1994). The relatively high numbers of walleye caught in dam tailraces during the spring suggest that walleye may be attracted to the concentrations of juvenile salmonids there. However, investigations of walleye food habits on the Lower Columbia River

suggest that walleye in the tailraces are not responding to concentrations of juvenile salmonids. Juvenile salmonids accounted consistently for only 18 to 24 percent of the walleye's diet (Sauter et al. 1994), even when large concentrations of juvenile salmonids were available.

Because of the relatively low level of juvenile salmonid consumption and relative scarcity of walleye in the Mid-Columbia River reservoirs, they are not considered to have a major impact on juvenile salmonid survival migration at this time.

Piscivorous Birds

Juvenile anadromous salmonids near tailraces of the Mid-Columbia River projects are also susceptible to predation by birds. Ring-billed gulls are the most prevalent avian predator in the Mid-Columbia River reach. In addition to gulls, other piscivorous birds known to prey on juvenile salmonids include cormorants, herons, terns, mergansers, and diving ducks (Mace 1983; Wood 1987; Schreck et al. 1997; Schreck and Stahl 1998; Collis et al. 1999, 2001). The birds primarily forage below dams where turbulent currents from the spillways and turbines disorient young juvenile salmonids and carry them near the surface. Ruggerone (1986) estimated that ringbilled gulls consumed 2 percent of the salmon and steelhead passing Wanapum Dam in 1982. Since that time, avian predator control measures (including wires strung across dam tailraces, hazing programs, and lethal shooting in some instances) have hindered bird access to vulnerable juvenile salmonids and are believed to have substantially reduced predation losses. Chelan County PUD in conjunction with the University of Washington, WDFW, and NMFS are currently assessing the impacts of piscivorous birds on juvenile migrating salmonids (see Section 3.5.5, Piscivorous Bird Control Activities).

3.2.10.3 Tributary Spawning and Rearing Habitat

There are four major tributaries in the project area: Wenatchee, Entiat, Methow, and Okanogan Rivers. By the turn of the century, logging, irrigation, and mining activities combined to severely impact the tributary habitats throughout the Columbia River Basin, including the Mid-Columbia River region. However, current conditions have improved because of the removal of small dams on some tributaries, screening of irrigation diversions, increased protection of riparian corridors from logging practices, and reduced mining activities. In addition, some habitat restoration or protection activities (such as improving fish passage conditions at culvert crossings, establishing minimum instream flow criteria, and restricting live stock access to stream bank and riparian areas) have improved the tributary habitat. Despite these improvements, tributary habitat quality and quantity is still a limiting factor in the recovery of anadromous fish stocks in the Mid-Columbia River region.

As a result of the long history of impacts to salmonid populations and their habitats in the Mid-Columbia River region, it is reasonable to assume a substantial reduction in the life-history diversity among these stocks. Decreased diversity is due, in part, to the simplification of the available habitat through riparian and streamchannel modifications, reduced instream flows, and the existence of fish migration barriers. Large-scale introductions of hatchery fish have also contributed to the reduction of life-history diversity within the stocks. Species that adopt several life-history patterns can maximize the use of diverse habitats, occupy vacant niches, and are more robust to periodic dramatic environmental upheavals in a watershed. As a greater percentage of the fish populations become reliant on a single habitat, the impacts resulting from a disturbance or elimination of that habitat also increase.

Habitat needs of anadromous salmonids in the Mid-Columbia River tributaries vary by season and life stage. Upstream adult migration, spawning, incubation of the eggs, juvenile rearing, and seaward migration of smolts are the major life stages for most anadromous salmonids.

Adult salmonids returning to their natal streams must arrive at the proper time and in good health if spawning is to be successful. Unfavorable flow, temperature, turbidity, or water quality conditions could delay or prevent fish from completing their migration. Man-made barriers (such as impassible drops, improperly installed culverts, diversion dams, impoundments, and excessive velocities) may also impede migrating fish.

Hiding and resting cover habitat, clean substrate of appropriate size and composition, and water quality and quantity are important habitat requirements for anadromous salmonids before and during spawning. Cover for fish can be provided by overhanging vegetation, undercut banks, submerged vegetation, woody debris, water depth, and turbulence.

Some anadromous fish (chinook salmon and steelhead, for example) enter the tributaries months before they spawn, so cover is essential for them during this holding period. The suitability of a particular size gravel substrate for spawning depends mostly on fish size, but all require gravel substrate, relatively free of silt.

The timing of hatching and fry emergence of salmon and steelhead varies among the different stocks and spawning areas. These differences are primarily due to variations in temperature during the incubation period. After hatching, alevins (yolk-sac larvae) remain in the gravel for an extended period of time. As their yolk-sacs are absorbed, alevins emerge from the gravel and disperse into a wide variety of habitats. Flow, water velocity, and depth determine the amount of suitable rearing habitat. Other important

features of suitable rearing habitat are substrate composition and cover habitat.

The highest production of invertebrates occurs in shallow water habitats with gravel and cobble substrate, and decreases with larger or smaller substrate material (NMFS et al. 1998a). The amount, type, and location of cover are important during the juvenile rearing phase because it provides food, shade (for temperature stability), and protection from predators.

Wenatchee Watershed

Wenatchee River has about 163 miles of stream accessible to anadromous salmonids. The Federal Government is the largest landowner in the watershed. Private ownership is limited to less than 25 percent of the total watershed area, but encompasses nearly two thirds of the lineal area of the anadromous streams (NMFS et al. 1998a). Most of these lands are irrigated orchard areas located in the lower watershed. Although the large diversions are equipped with modern fish screens, many unauthorized smaller intakes may be operating without screens (NMFS et al. 1998a).

Fish Resources

The Wenatchee River supports several populations of economically and culturally important fish species. The watershed currently supports anadromous runs of chinook salmon, sockeye salmon, and steelhead. Native coho salmon were once present in the Wenatchee watershed (Mullan et al. 1992), but are now extinct (Nehlsen et al. 1991). Other abundant resident species include mountain whitefish, kokanee (landlocked sockeye salmon), bull trout, rainbow trout (a resident form of steelhead), and westslope cutthroat trout. A discussion of the three major evolutionary life-history strategies (ocean-type, stream-type, and resident) exhibited by these fish populations is provided below.

Spring-Run Chinook Salmon

Spring-run chinook salmon return to the Wenatchee River from late April through June. Spawning begins in early August in the upstream reaches of the tributaries, and continues downstream through September. Juveniles emerge from the gravel from late March through early May, generally spend their first summer in the subbasin, and leave in late fall through the following spring. The peak of spring migration is late April through May. The average estimated natural escapement to the Wenatchee River (based upon redd count expansions) is 2,929 fish for the period 1960 to 1969, 2,354 fish for the period 1970 to 1979 (NMFS et al. 1998b), 2,482 fish for the period 1980 to 1989, and 473 fish for the period 1990 to 1999 (NMFS 2001a). Estimated escapement (based on unexpanded redd counts) for 2000 and 2001 were approximately 1,600 and 12,000, respectively (Peven 2002 personal communication).

The primary spawning areas are the Chiwawa River between Grouse and Phelps Creeks, Nason Creek between Kahler and Whitepine Creeks, the Little Wenatchee River between river mile 0.6 and 7, the White River between Sears Creek and White River Falls, and the mainstem Wenatchee River between Chiwaukum Creek and Lake Wenatchee (Peven and Truscott 1995). Spawning is observed annually in Icicle Creek as well, but it is likely that most of these fish are of hatchery origin (Washington Department of Fish [WDF] et al. 1993). A limited amount of spawning has also been reported in Peshastin, Chumstick, and Mission Creeks (USFS 1994a).

Summer/Fall-Run Chinook Salmon

Summer/fall-run chinook salmon return to the Wenatchee River primarily in July and August. They spawn in the mainstem between the outlet of Lake Wenatchee downstream to the confluence with the Columbia River (about 54 miles). Juveniles generally immigrate to the ocean as subyearling fry, leaving the Wenatchee River from 1 to 4 months after emerging from the gravel in April. However, it is likely that some

cohorts also rear in the mainstem, Lake Wenatchee, or tributaries through winter when conditions are favorable to this strategy. Summer/fall-run chinook salmon are most dependent on habitat in the mainstem Wenatchee River downstream of Plain. From 1960 to 1994, the average escapement of ocean-type chinook salmon was 8,826 fish (based on differences in adult and jack counts at Rock Island and Rocky Reach dams), with a range from 3,394 to 13,625 fish. However, estimated escapements in 2000 and 2001 were approximately 19,000 and 23,000 adults, respectively (Peven 2002 personal communication).

Sockeye Salmon

Columbia River sockeye salmon adults generally begin entering the river in April and May. Peak passage at Bonneville Dam typically occurs around the third week in June, and about 1 month later at Rock Island (Chapman et al. 1995b). However, the Wenatchee sockeye salmon population migrates upstream earlier than the Okanogan stock. The principle spawning areas for Wenatchee River sockeve salmon are river mile 0 to 5 on the Little Wenatchee River, from river mile 6 to 10 on the White River, and the lower reaches of Nepeequa River (WDF et al. 1993). In addition, some fish may spawn along the shoreline at the upper end of Lake Wenatchee. As such, sockeve salmon are vulnerable to bulkhead construction because of mechanical damage to redds, altered gravel composition, and reduced nutrient input.

Unauthorized filling and disruption of springs and groundwater seeps, and removal of riparian vegetation also would affect these spawners and decrease fry production. Spawning occurs from mid-September to mid-October. Juveniles move downstream from the rivers to Lake Wenatchee immediately after they emerge from the gravel (March through May). Most of the juveniles (about 82 percent) reside in Lake Wenatchee for 1 year prior to emigration, while some reside 2 years in the lake. A small percentage of sockeye

salmon remain in Lake Wenatchee their entire life as kokanee.

Steelhead

In general, adult steelhead migrate into the Mid-Columbia River tributaries in both fall and early spring. Spawning occurs primarily in late March, but may extend longer in some years. Steelhead use the mainstem Wenatchee River and eight of its tributaries: Lower Mission, Sand, Brender, Peshastin, Chumstick, Icicle, Chiwaukum, and Nason Creeks, and the Chiwawa, Little Wenatchee, and White Rivers. Fry emerge in late spring to August and they disperse downstream in late summer and fall. Some fry and parr rear in the mainstem Wenatchee all year. They exhibit a wide range of life-history characteristics, including highly variable, freshwater residence periods, and a broader range of spawning areas (extending higher in the tributaries than streamtype chinook salmon).

Those individuals using upper reaches of tributary habitats (Peshastin and Mission Creeks), have probably been more heavily impacted by forest practices, improper grazing practices, stream channel alterations, and unauthorized water withdrawals than have stream-type chinook salmon. Again, riparian and shoreline impacts are a major problem. Smolts typically leave the Wenatchee River in March to early June, after residing 1 to 7 years in freshwater. Although most leave after 2 or 3 years, some remain in freshwater their entire lives (Peven et al. 1994).

Resident Salmonids

Resident rainbow trout, bull trout, and westslope cutthroat trout use the Wenatchee River and tributary habitat for most or all their life. Although little is known about their specific population dynamics or demographics, they are presumed to exhibit a wide range of life-history patterns.

Bull Trout. The principal spawning areas for bull trout in the Wenatchee River are in Panther Creek (tributary to White River), and the

Chiwawa River and other selected tributaries (Rock, Chikamin, Phelps, Alpine, James, and Buck Creeks) (Brown 1992b). Other lesser populations are known to occur in Nason, Chiwaukum, Eightmile, French, and Ingalls Creeks. Recent radio-telemetry evaluations report that four of eight tagged bull trout moved into tributary streams, while the others remained in mainstem areas (BioAnalysts, Inc. 2002). Bull trout occur throughout the mainstem Wenatchee River from the Columbia River to Lake Wenatchee, although their numbers appear to be low in most areas upstream of Tumwater. The lacustrine form principally spawns in the White River drainage, whereas those bull trout that spawn in the Chiwawa drainage exhibit more of a fluvial life-history strategy (Brown 1992b).

Fishing pressure is a major factor in the decline of bull trout in the Wenatchee watershed (Brown 1992b). In 1992, however, harvest of bull trout was prohibited in the Columbia River and most tributaries of Washington State, including the Wenatchee watershed. With the exception of high levels of sediment in some spawning areas, the new USFS prescriptions for managing stream corridors and riparian habitat are considered adequate for protection of bull trout on public lands (Brown 1992b). However, the consequences of past activities continue to affect bull trout and their habitat (USFWS 1998).

Westslope Cutthroat Trout. Several genetically "pure" and "essentially pure" cutthroat populations occur in the Wenatchee watershed. These populations include: Chiwawa River (Phelps, Rock, Buck Creeks, and the mainstem headwaters), Little Wenatchee River (Rainy, Lake, and Snowy Creeks, and the mainstem headwaters), White River (Napeequa River and mainstem headwaters), Nason Creek (Smith Brook and Gill Creek, and the mainstem headwaters), Icicle Creek (Jack and French Creeks, and mainstem headwaters), and Negro Creek in the Peshastin drainage. Other creeks may have genetically pure or essentially pure

stocks, but these populations have not been sampled.

Habitat Conditions

Forest practices can result in multiple habitat impacts, including reduced riparian canopy, increased fine sediment loads, reduced pool habitat, lost off-channel habitats, and increased run-off. Prior to 1988, timber harvests in the watershed left no stream-side buffers along the channels. However, subsequent harvests have incorporated minimum riparian buffers on fishbearing streams that do not necessarily provide adequate shade or large woody debris recruitment.

Water quality is generally good in the Wenatchee River but water temperatures are above those preferred by salmonids in July, August, and September, particularly during low flow years. The agrarian and historical logging land use practices have increased summer water temperatures above what they would be under natural conditions, and conversely, have probably decreased winter temperatures.

Although fish habitat protection is of primary concern to fishery managers, they have only limited jurisdiction over land and water uses that impact habitat. The Peshastin Creek channel is largely defined by Highway 97. Chumstick and Mission Creeks have been straightened and realigned along much of the historical anadromous zone. While the portion of Icicle Creek still accessible to anadromous fish remains highly sinuous, its banks have been rip-rapped along much of this reach, and its historical maze of side channels and oxbows have been filled in, or cut off from the main channel.

Riparian and Stream Channel Condition

Flood control dikes, gravel mining, and channel straightening associated with rail lines and roads have dramatically simplified habitat in the lower mainstem Wenatchee River. Wood removal, and the loss of wood recruitment resulting from these and other actions have exacerbated conditions.

Today, the lower mainstem is almost entirely devoid of large woody debris, and there is virtually no remaining riparian vegetation. These practices, in combination, constitute the greatest impact to salmonid habitat in the mainstem Wenatchee downstream of Leavenworth.

In general, the lower mainstem river channel would be described as a moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools and stable banks. The upper mainstem Wenatchee River (from Chiwaukum confluence upstream) is a low-gradient, meandering, point bar, riffle/pool, alluvial channel with broad, well-defined floodplains.

The Upper Wenatchee River between the Lake Wenatchee and Leavenworth is impacted less than the reach downstream of Leavenworth. Some rip-rap and general bank protection projects exist in the Plain area along with riparian clearing near some homes along the river. Downstream from Leavenworth, orchards and homes now occupy much of the river's riparian area.

White River

The Lower White River is the principal spawning area for sockeye salmon and adfluvial bull trout. It has an average slope of 1 percent and has shallow entrenchment within a wide, flat-floored, glacial valley. The stream is about 65 feet wide (wetted width), with a relatively even distribution of pool, glide, and riffle habitat. Stream canopy cover is also relatively good.

Nason Creek

Nason Creek flows through a sedimentary glacial canyon, and is relatively unconfined. There are some areas of excessive scour from both natural events and human alterations, and other areas are altered by rip-rap placement. Some side channels and oxbows have been cut off from the main channel by construction of U.S. Highway 2.

Chiwawa River

The Chiwawa River is the largest tributary to the Wenatchee River. Private homes and property are adjacent to Chiwawa River for the first 5 miles, near the confluence of Chikamin Creek and in several other tributary sections. In general, the habitat is riffle dominated, with pools associated with log jams and meanders, although the river has limited large woody debris or pools per unit stream length. No known fish passage barriers occur in the stream. There are numerous roads throughout the watershed. A water diversion is located at river mile 4.4, and has a capacity of diverting 30 cfs that may reduce downstream rearing habitat in late summer. A satellite to the Rock Island Fish Hatchery Complex is located at river mile 0.6.

Icicle Creek

Lower Icicle Creek is an unconfined alluvial stream, with a relatively low gradient. An unquantified but substantial amount of stream bank has been altered by riparian vegetation removal or rip-rap placement. The barrier dam at Leavenworth National Fish Hatchery is reported to block access to more than 19 miles of historical habitat. However, there is some indication that a natural barrier about 3 miles upstream from the hatchery might be the historic upstream extent of anadromous fish access (Clubb 2001 personal communication). Viable populations of rainbow trout, bull trout, cutthroat trout, and brook trout occur upstream of this barrier.

Chumstick Creek

Chumstick Creek is a substantial source of sediment to the Wenatchee River due to riparian habitat degradation along the creek. Although there is some potential for steelhead and streamtype chinook salmon production, this system appears primarily suited for coho salmon. A large culvert under the North Peshastin Road (near the mouth of Chumstick Creek) is a passage barrier for adult salmonids, and several smaller upstream culverts are suspected to hinder upstream passage of salmonids at certain times. Summer flows, at least in drier years, appear to be

low enough to prevent adult salmonid staging and spawning. Juvenile salmonids have been observed in Lower Chumstick Creek, closely associated with the patchy riparian cover.

Peshastin Creek

Stream-type chinook salmon still use this system. Historically, steelhead and coho salmon probably spawned in this system. Irrigation diversions are suspected of blocking adult migrations; however, small numbers of chinook salmon have spawned in Peshastin Creek in some recent years (Peven 2002 personal communication). The effects of water diversions on juvenile rearing are not known.

Riparian vegetation along the mainstem, where it has not been totally cleared, is primarily deciduous trees and shrubs. As a result, the mainstem channel receives a very limited supply of the large woody debris. Currently, in-channel conditions appear to limit stream-type chinook salmon overwintering above the U.S. Highway 2 crossing. Below the crossing, the gradient flattens considerably, but the lack of riparian vegetation also makes for poor rearing and overwintering habitat. The stream channel in Peshastin Creek has been altered and straightened by construction of U.S. Highway 97 from the mouth to Scotty Creek. As a result, water velocities (and resultant bedload) are very high, making this stream virtually unusable by salmonids at all life stages.

Mission Creek

Mission Creek is a substantial source of sediment to the Wenatchee River. Adult stream-type chinook salmon cannot get above the irrigation diversions (steelhead can in wet years), and the spawning conditions in the lower creek are generally unsuitable. High sediment loads, peak flows, and pre-spawning water temperatures, along with limited adult resting habitat, are all problems for stream-type chinook salmon in this watershed. Juvenile chinook salmon and rainbow/steelhead overwinter in Lower Mission and Brender Creeks, however.

Lake Wenatchee

Lake Wenatchee is the only nursery lake for sockeye salmon in the Wenatchee watershed. It is a typical oligotrophic lake, being relatively clear with low productivity. Mullan (1986) classified Lake Wenatchee as classic sockeye salmon rearing habitat: cold, clear well-oxygenated, but infertile water. The White and Little Wenatchee Rivers deliver most of the inflow, as the basin is relatively small, and the Wenatchee River is the outflow.

Lake Wenatchee is highly susceptible to housing development. The amount of shoreline development that has occurred along the lake has increased in recent years. Many bank hardening and dock construction permits have also been issued. Such activities disrupt sediment dynamics and decrease the productivity of littoral zones. The construction of bulkheads, removal of riparian vegetation, and shoreline clearing on Lake Wenatchee is a departure from natural conditions. This practice reduces wood and nutrient recruitment to the lake and downstream habitats.

The Relationship of Existing Aquatic Habitat Conditions to Biological Productivity

Ocean-Type Chinook Salmon

These fish encounter habitat that has been heavily impacted by development in the valley bottomlands. It is believed that summer-run chinook salmon spawning in the Lower Wenatchee River (downstream of Mission Creek confluence) do not enter the river until shortly before they spawn. Thus, they avoid warm water conditions and usually encounter higher flows than earlier spawners encounter. Flows during the second half of October are on average 25 percent higher than those in the latter half of September. However, in drier years, later migrating fish may have difficulty accessing the area upstream of Leavenworth. Sedimentation, gravel scour and anchor ice are potential sources of pre-emergence mortality.

The early rearing environment for chinook salmon is relatively poor. The combination of natural and artificial channel confinement severely limits the availability of suitable early rearing habitat. Velocity refugia are primarily associated with rip-rap and afford little cover from predators. Habitat limitations include velocity refugia and cover. Late rearing habitat quality is also limited by a lack of in-channel diversity. The lack of cover, particularly as flows drop in the summer and fall, may be limiting the success of this group of fish.

Overwinter habitat quality was also severely reduced by the actions described above. Winter water temperatures often hover near freezing, so ice can occupy most of the substrate in this reach in a cold winter with low flows.

Stream-Type Salmonids

Based on stream survey information (from USFS, WDFW, and Chelan County PUD) and the observations of fish biologists familiar with the basin, most Wenatchee River stream-type anadromous fish spawn higher in the watershed than ocean-type fish, in habitats least modified by land use practices. Early rearing also occurs in more pristine areas (Hillman and Miller 1994). A portion of the juvenile population may move downstream gradually during summer and fall for over-winter rearing. Here they encounter increasingly altered conditions where recruitment of shelter habitat (primarily large woody debris) and food supply is reduced because of the loss of forested riparian areas. Conditions in the Upper Chiwawa and White Rivers are considered particularly good, whereas Nason Creek has been straightened and contains limited large woody debris in most of the anadromous zone. Similarly, the mainstem Wenatchee River in and around Plain and the Lower Chiwawa River have lost considerable large woody debris and inchannel diversity as a result of shoreline development.

Forest practice impacts to stream-type salmonids are expected to improve if the riparian buffers

required by the USFS remain in effect, and if forest road construction techniques and maintenance standards continue to improve. The Little Wenatchee River and Nason Creek each experience very low flows during the late summer, but it is not known whether this phenomenon results from forest management. The current forest hydrology models that have been applied to these watersheds indicate only slight exacerbation of peak and summer low flows. No data regarding spawning gravel condition are available. The upper mainstem Wenatchee River still shows the scouring effects of historical in-channel log drives.

Shoreline development is the greatest in-basin habitat problem and probably the greatest threat to this salmonid life-history type, especially in the lower river rearing and overwintering zones. The areas most threatened by additional development are the White River below the Nepeequa River, the Chiwawa River below Deep Creek, most of the anadromous portion of Nason Creek, and the Wenatchee River mainstem between Lake Wenatchee and Tumwater Canyon.

Stream-type anadromous salmonids that spawn or rear in the middle and lower sections of main tributaries encounter conditions different from those that existed before development. Water withdrawals are significant problems in all of the lower river tributaries. Portions of Peshastin and Mission Creeks may be completely dewatered, during the late summer, by irrigation withdrawals. Icicle and Chumstick Creeks may also be diverted.

Sockeye salmon spawning habitat is limited to the lower gradient riffles within the accessible portions of the White, Little Wenatchee, and Nepeequa Rivers. Suitable spawning areas exist primarily where the rivers and their floodplains are unconfined. About half of the spawning habitat in the White River is bordered by private property. Development reduces the riparian vegetation, and stream banks begin to erode. If

this situation continues on the White River, sockeye salmon production will likely decline.

Large woody material and higher flows provide cover to protect fish from poaching, harassment, and predation for mature stream-type anadromous salmonids in the summer and fall. Importance of shelter habitat increases as forest road construction provides easier fishing access and vulnerability to legal and illegal harvest.

Resident Fish

Many of the key habitat factors that apply to anadromous salmonids also apply to resident fish. Resident salmonids are found with anadromous fish in many areas but usually reside in smaller order streams with higher gradients. They occur primarily in more forested drainages away from many of the habitat problems associated with bottomland development (bank protection, channelization, water withdrawal). Key habitat conditions for resident fish (in particular, rainbow trout, westslope cutthroat trout, and bull trout) revolve around minimizing sedimentation and gravel scouring and providing the necessary cool water temperatures and adequate cover.

Entiat Watershed

The Entiat watershed is the smallest of the four considered in this assessment, and probably also the simplest ecosystem. About 90 percent of the watershed is publicly owned. Less than 25,000 acres is privately owned, although more than 75 percent of the riparian habitat for anadromous salmonids in the mainstem Entiat River is privately owned. Most of the upper drainage is considered a Federal key watershed for bull trout, salmon, and steelhead. The Entiat Basin suffered four major burns within the last 25 years: the Entiat Fire in 1970 (burned 22 percent of the watershed), the Crum Canyon Fire in 1976 (4 percent), the Dinkleman Fire in 1988 (20 percent), and the Tyee Fire in 1994 (36 percent).

Fish Resources

The Entiat River supports several populations of economically and culturally important fish species. The watershed currently supports anadromous runs of chinook salmon and steelhead. Coho salmon were once present in the Entiat watershed (Mullan et al. 1992), but are now considered extinct (Nehlsen et al. 1991). Passage barriers on the Entiat River at the turn of the century probably contributed to their extinction. Important inland species include mountain whitefish, bull trout, westslope cutthroat trout, and rainbow trout. A recreational fishery exists for resident rainbow and brook trout. No sport fishing for bull trout, salmon or steelhead is allowed on the Entiat River. The spring- and summer-run chinook salmon and steelhead populations were listed as depressed (WDF et al. 1993).

In general, spawning and rearing habitat for salmon and steelhead are considered to be in very good condition in the Upper Entiat River (from Potato Creek confluence to Entiat Falls) and poor in the Lower Entiat River (USFS 1996).

Spring-Run Chinook Salmon

Stream-type (spring) chinook salmon return to Entiat River from late May through July. The primary spawning areas are the mainstem river upstream of the terminal moraine (river mile 16) to Fox Creek confluence (river mile 28). Spawning begins in early August in the upstream reaches, and continues downstream through August and September. The average escapement estimate, based on dam counts (turnoff estimates), has decreased from about 3,229 redds for the period 1960 to 1969, to about 1,056 redds for the period 1990 to 1995. However, some of these escapement values are not corroborated by redd count expansions, done recently by USFWS (Carie 1996).

Juveniles emerge from the gravel from late March through early May, generally spend their first summer in the subbasin, and leave in late fall through the following spring. The peak of the spring migration is late April through May, but downstream movement from the tributaries may be continuous, and not always associated with parr/smolt transformation.

Summer/Fall-Run Chinook Salmon

It is suspected that ocean-type summer/fall-run chinook salmon were not a dominant life-history strategy in the Entiat River system (Craig and Suomela 1941). Ocean-type chinook salmon return to the Entiat River primarily in July and August, but may enter the river as late as early October. They spawn in the mainstem Entiat River from the Preston Creek confluence downstream to its confluence with the Columbia River (23 miles). Spawning begins in late September in upstream reaches, peaks mid-October, and ends in early November in the lower river (Peven 1992). Juveniles probably immigrate to the ocean as subvearlings, leaving the Entiat River from 1 to 4 months after emerging from the gravel in April.

Based upon redd counts, the ocean-type chinook salmon escapement to the watershed averaged 37 for the period 1957 to 1966, 55 redds for the period 1967 to 1976, 9 redds for the period 1977 to 1986, and 11 redds for the period 1987 to 1991. In 1995, 40 ocean-type chinook salmon redds were observed in the mainstem Entiat River downstream of river mile 20. No summer-run chinook salmon spawn in the tributaries of Entiat River. Juveniles may rear from a few months to a year before migrating downstream. Two general life-history types are presumed for ocean-type anadromous fish in the basin: (1) spawn in the mainstem and leave the system in late spring/summer as subyearlings, and (2) spawn in the mainstem and leave the system in fall as subyearlings. However, some cohorts rear in the Entiat River through winter when conditions are favorable to this strategy.

Sockeye Salmon

Sockeye salmon are not indigenous to the Entiat River (Craig and Suomela 1941). After they were propagated at Entiat National Fish Hatchery

between 1941 and 1969, small numbers of sockeye salmon adults are occasionally observed in the Entiat River during spawning ground surveys for chinook salmon (Carie 1996). These fish are either strays from the Wenatchee and Okanogan stocks, or they may be artifacts of the Entiat National Fish Hatchery releases (Mullan 1986). Little is known about the life-history of Entiat sockeye salmon; they are assumed to rear primarily in the impounded lower reach of the Entiat River and the mainstem Columbia River (Chapman et al. 1995b). Spawning occurs from mid-September to mid-October. It is assumed that juveniles move downstream from the Entiat River to the Columbia River reservoir immediately after they emerge from the gravel (March through May).

Steelhead

Steelhead spawn in the Upper Entiat River and some tributaries from mid-March through late May. Most steelhead spend 1 to 2 years rearing in the mainstem or its tributaries, although an almost continuous outmigration from the river occurs during this period. Movements are complex and not fully explainable. Hatchery steelhead are no longer released in the Entiat River.

Natural steelhead stock/recruitment relationships from several reports show little or no replacement. For at least the last 20 years, natural spawning populations in the system are predominantly of hatchery origin. Steelhead exhibit a wide variety of life-history strategies. Again, riparian and shoreline impacts are a major in-basin problem for steelhead.

Resident Salmonids

Resident rainbow trout, bull trout, and westslope cutthroat trout use the Entiat River and tributary habitat most or all their life. Although little is known about their specific population dynamics or demographics, they are presumed to exhibit a wide range of life-history patterns. However, recent radio-telemetry data indicates that bull trout migrate between the Entiat River and the

mainstem Columbia River, although the overall extent of these migrations is not currently known (BioAnalysts, Inc. 2002).

Many of the key habitat factors that apply to anadromous salmonids also apply to resident fish. Resident salmonids are found with anadromous fish in many areas but usually reside in smaller order streams with higher gradients. They occur primarily in more forested drainages away from many of the habitat problems associated with bottomland development (bank protection, channelization, water withdrawal). Key habitat conditions for resident fish (in particular rainbow trout, westslope cutthroat trout, and bull trout) revolve around minimizing sedimentation and gravel scouring, and providing cover.

Habitat Conditions

Forest practices impacts are minor in the Roaring Creek drainage, but they are significant in some smaller tributaries (Burns, Preston, Brenegan, and McCree Creeks). Forest roads in the Potato, Mud, and Crum watersheds are typically located in the narrow floodplains of the mainstems and their tributaries. This road location practice can result in multiple habitat impacts including reduced riparian canopy, increased fine sediment loads, reduced pool habitat, and lost off-channel habitats. Such roads also directly reduce watershed storage capacity by rapidly routing run-off into stream channels and by compacting floodplain soils, and also indirectly by discouraging beaver pond construction. Recently, there have been extensive road obliteration and reconstruction projects in the Wenatchee National Forest—primarily for riparian restoration. Timber harvests have left buffers on fish-bearing streams, but the minimum requirements do not always result in adequate shade or large woody debris recruitment.

Upland erosion is a chronic problem in the Entiat watershed, yet substantial restoration efforts are underway in the Wenatchee National Forest to address this problem. Several stream bank stabilization projects are proposed for the erosive

banks on the mainstem Entiat River. Using properly applied bioengineering methods, these projects can provide instream habitat for adult and juvenile salmonids.

However, such remedies are not an adequate substitute for natural stream channel/floodplain conditions. Road closures and obliteration. extensive reforestation, culvert upgrades and other efforts are currently proposed for the forest, and will help to improve fish habitat. There are highly erosive areas along Fox, McCree, Brenegan, Preston, and Mud Creeks, Crum Canyon, and the mainstem Entiat between Fox and Stormy Creeks. Relative to hazards from forest land erosion and fluvial sedimentation, stream bank erosion is not a significant problem on the Entiat River-mostly because the riparian vegetation in the upper reach is adequate for avoiding erosion, and the Army Corps of Engineers has provided extensive channeling and rip-rap armoring in the lower reach.

To protect stream-type chinook salmon, WDFW recently imposed selective resident fishery regulations throughout much of the anadromous fish zone that should significantly reduce juvenile hooking mortality. Portions of the zone however, remain open to bait fishing. The recently abandoned practice of planting catchable hatchery rainbow trout in this portion of the subbasin probably had some impact on chinook salmon smolt production. Large woody material and higher flows provide cover habitat to protect mature stream-type anadromous salmonids from poaching, harassment, and predation. Importance of cover habitat increases as forest road construction provides easier fishing access and vulnerability to legal and illegal harvest.

Water temperatures are not a serious problem in the Lower Entiat River; maximum temperatures are typically less than 15° C, which is tolerable for rearing juveniles. In winter, anchor ice is a problem in the Entiat below Ardenvoir and in the Mad River. Sediment levels, especially fine sediments, are impacting beneficial uses, primarily aquatic habitat and irrigation. These sediments are derived from both natural and human-caused (accelerated) sources.

Riparian and Stream Channel Condition

Based upon the 1995 stream channel inventory and work presented in Mullan et al. (1992), habitat diversity in Lower Entiat River is remarkably low (riffle:run:pool ratio is 0.72:0.25:0.03). In contrast, the upper reach has 28 percent pools, which the USFS rates as good. The distribution of large woody debris is similar, with a low incidence in the lower river and appreciably better in the upper reaches. These two factors (lack of pools and woody debris), are the primary limitations to natural production of salmon and steelhead on Lower Entiat River. Much of this can be attributed to the flood-control projects undertaken by the Army Corps of Engineers under the 1946 Federal Flood Control Act.

Most habitat upstream of Entiat Falls is rated as fair to excellent, with fewer than 25 percent of the surveyed reaches in the upper river not meeting the USFS standard for pool habitat (USFS 1996). The habitat quality between McCrea Creek and Entiat Falls is rated as fair to excellent, and habitat quality downstream of McCrea Creek is rated as fair to poor (USFS 1996). Spawning and rearing habitat in Mad River is poor to fair up to Young Creek, which is well beyond the reach of anadromous salmonids.

The Entiat valley was impacted by major flood events in the 1940s and 1970s. As a result, virtually all of the lower 22 miles of the Entiat River has been channeled—a dike on one side, and the Entiat River road on the other. Stream sinuosity is low, with very few point bars for gravel accumulation. The lower 12.5 miles of the mainstem Entiat River is highly channeled, resulting in a trapezoidal stream channel for the bankfull width. Instream habitat diversity is very low, with few pools, glides, or pocket water. As a result, there are very few resting areas for both adult and juvenile salmon.

The lower mainstem is almost entirely devoid of large woody debris, and there are some areas with no remaining riparian vegetation. These conditions constitute the greatest impact to salmonid habitat in the mainstem Entiat downstream of Mad River. Sedimentation, gravel scour and anchor ice are potential sources of preemergence mortality. The early rearing environment is fairly hostile; the combination of natural and artificial channel confinement severely limits the availability of suitable early rearing habitat.

Velocity refugia are primarily associated with riprap and afford little cover from predators. Late rearing habitat quality also lacks in-channel diversity. The lack of cover, particularly as flows drop in the summer and fall, may also be limiting the salmonid productivity. Overwinter habitat is also limited in the lower river due to ice often occupying most of the substrate in a cold winter following a dry summer.

Methow River Watershed

Methow watershed has five subwatersheds, and a total drainage area of 1,146,800 acres. Of the four watersheds in the Mid-Columbia River region, the Methow watershed has the most land in public ownership (94 percent), yet it ranks low in annual flows (about 1,600 cfs, measured at Pateros). Methow watershed has an average runoff (cfs) per square mile of drainage area of 1.1 cfs, compared to 1.9 cfs and 2.6 cfs for the Entiat and Wenatchee watersheds, respectively (Mullan et al. 1992). Most of the riparian bottomlands in the reach accessible to anadromous salmonids are privately owned. Very little of the watershed is irrigated agriculture. Only 12,800 acres of the private land in the basin are irrigated cropland (orchard, pasture, and hay); the majority of the watershed is National Forest land.

Fish Resources

The Methow River supports several populations of economically and culturally important fish species. The watershed currently supports

anadromous runs of chinook salmon and steelhead. Sockeye salmon are occasionally observed (Chapman et al. 1995b). Important inland species include mountain whitefish, bull trout, rainbow trout, and westslope cutthroat trout. Currently, there is a catch and release sport fishery for rainbow and cutthroat trout between Gold Creek and Weiman Bridge on the Methow River and a limited catch and release fishery for rainbow and cutthroat trout on the Twisp and Chewuch Rivers. Bull trout, rainbow trout, and cutthroat trout continue to be legally harvested from the Lost River, a tributary to the Upper Methow River. Wild spring- and summer-run chinook salmon and steelhead populations were listed as depressed (WDF et al. 1993). Fish passage into the Methow River was significantly impeded from 1912 until the 1930s by a hydroelectric dam built across the river at Pateros.

Spring-Run Chinook Salmon

Stream-type spring-run chinook salmon return to Methow River from late May through July. The primary spawning areas are the mainstem Methow River upstream of the Chewuch River confluence, the Twisp, Chewuch, and Lost Rivers, as well as Thirtymile and Lake Creeks. Spawning is observed occasionally in Foghorn Ditch as well, but it is likely that the fish spawning here are of hatchery origin (WDF et al. 1993). A very limited amount of spawning has also been reported in Early Winters, Wolf, and Gold Creeks (USFS 1994b).

Spawning begins in early August in the upstream reaches of the tributaries, and continues downstream through August and September. The average estimated natural escapement to Methow River (which includes wild and hatchery fish, and is based upon redd count expansions) is 3,429 for the period 1960 to 1969, 2,471 for the period 1970 to 1979, 1,061 for the period 1980 to 1989, and 772 for the period 1990 to 1995. The escapement to Methow River (as measured at Wells Dam) for the period 1996 to 2002 ranged from a low of 126 in 1995 to a high of 11,157 fish in 2001.

Juveniles emerge from the gravel from late March through early May, generally spend their first summer in the subbasin, and leave in late fall through the following spring. The peak of the spring migration begins around the end of April and continues through May, but downstream movement from the tributaries may be continuous, and not always associated with parr/smolt transformation.

Summer/Fall-Run Chinook Salmon

Ocean-type summer/fall-run chinook salmon return to the Methow River primarily in July and August, but may enter the river into early October. No summer-run chinook salmon spawn in the tributaries of the Methow, and virtually all summer-run chinook salmon spawn downstream of the Chewuch River confluence, a total of about 42 miles of spawning habitat. That section consists of four valley bottom types. Spawning begins in late September in the upstream reaches and ends in early November in the lower river. Emergence timing is probably January through April. Juveniles may rear from a few months to a year before migrating downstream. Juveniles generally immigrate to the ocean as subyearling fry, leaving the Methow River from 1 to 4 months after emerging from the gravel in April.

Ocean-type salmonids are most dependent on habitat in the mainstem Methow River. From 1967 to 1991, the average redd deposition of ocean-type chinook salmon to the Methow River was 464 redds (based on adjusted aerial survey estimates), with a range from 93 to 1,055 redds.

Sockeye Salmon

Sockeye salmon adults are observed nearly every year in Methow River during spawning ground surveys for chinook salmon. The 1990 to 1994 average number of sockeye salmon observed in the Methow River was 53 (range: 13 to 90) (Chapman et al. 1995b). These fish are either strays from the Wenatchee and Okanogan stocks, or they may be artifacts of the Winthrop National Fish Hatchery releases between 1945 and 1958 (Mullan 1986). Genetically and demographically,

these salmon appear to be more similar to the Wenatchee stock than the Okanogan stock (Chapman et al. 1995b).

Little is known about the life history of Methow sockeye salmon; they are assumed to rear primarily in the impounded lower reach of the Methow River and the Columbia River mainstem (Chapman et al. 1995b). Although not generally referred to as such, sockeye salmon are "streamtype" in that they reside in freshwater (nursery lake) for more than a year. Spawning occurs from mid-September to mid-October. It is assumed that juveniles move downstream from the river to the reservoir immediately after they emerge from the gravel (March through May).

Steelhead

Steelhead use the mainstem Methow River and eleven of its tributaries: Black Canyon, Gold, Libby, Benson, Beaver, Early Winters, and Wolf Creeks; and the West Fork Methow, Chewuch, Twisp, and Lost Rivers (NMFS et al. 1998a). In general, steelhead adults migrate into the Methow River in both fall and spring after spending 1 to 3 years in the ocean (Wydoski and Whitney 1979). Spawning is initiated as early as late March, and can extend into July. Their eggs incubate from late March through June, and fry emerge in late spring to August.

Steelhead exhibit a wide range of life-history strategies throughout the basin. Fry and smolts disperse downstream in late summer and fall. Some fry and parr rear in the mainstem Methow River all year. Their use of tributaries for rearing is variable, depending upon population size, and both weather and flow conditions. Most smolts leave the Methow River in March to early June, after spending 1 to 7 years in freshwater, but most leave after 2 to 3 years (Peven et al. 1994). However, some steelhead residualize and spend their entire lives in freshwater. Thus, some naturally produced steelhead are outmigrating from the river throughout much of the year.

After nearly 14 months of rearing in a hatchery (primarily Wells fish hatchery, but recently also at Winthrop National Fish Hatchery), the smolts are planted into the mainstem Methow River from 20 April until 20 May. Almost 10 percent of these hatchery fish stay an additional year in freshwater prior to emigration. Most steelhead smolts leave the system at age 2 or 3, depending upon stream temperatures, and spend 2 years at sea. Currently, and for at least the last 20 years, steelhead spawning in the watershed are predominantly hatchery descendants.

The average hatchery steelhead run size from 1983 to 1992 was 15,015 fish, with an average sport catch of 7,804 fish and Tribal catch of 388 fish, thus leaving 6,623 fish to escape to spawn in the Methow watershed. Natural steelhead comprise about 10 percent of the total steelhead run in the Methow River system. Depending upon assumptions of hatchery fish viability, the stock recruitment relationships for Methow River natural steelhead are either at replacement or markedly below replacement (Appendix E).

Resident Fish

Resident rainbow trout, bull trout, and westslope cutthroat trout use Methow River and tributary habitat most or all their life. Although little is known about their specific population dynamics or demographics, they are presumed to exhibit a wide range of life-history patterns in the basin.

The status of rainbow trout in the Methow River is not known. It is assumed that the Methow system contains a mixture of full time resident rainbow and ocean migrating steelhead. Mullan et al. (1992) detected rainbow trout/steelhead in the mainstem Methow from the mouth to river mile 76.5, and in selected reaches of the following tributaries: Gold, Lake, Wolf, Early Winters, Foggy Dew, Crater, Beaver, Bridge, War, Eightmile, Twentymile, Goat, and Trout Creeks; the Twisp, Chewuch, and Lost Rivers.

Bull trout have been sampled or observed in selected reaches of: Buttermilk, Goat, Wolf, Early

Winters, Lake, Reynolds, South, and Monument Creeks; Lost and Twisp Rivers, and the West Fork and mainstem Methow River (Mullan et al. 1992). Recent radio-telemetry data indicated that 15 of the 39 tagged bull trout released at Wells, Rocky Reach, and Rock Island dams migrated into the Methow River prior to the spawning period in 2001 (BioAnalysts, Inc. 2002). Eleven of these fish migrated into the Twisp River drainage, and one repeatedly moved between the mainstem Methow River and Libby Creek. The others were only detected in mainstem areas of the Methow River.

Brook trout have been widely stocked into the Chewuch and Twisp Rivers since the 1920s. These fish are prolific in some tributaries to these rivers and pose a substantial risk to bull trout because these two species hybridize, and produce sterile offspring (Platts et al. 1993).

Habitat Conditions

Water withdrawal is a major factor in the overall management of the Methow watershed, but is practiced on only 1 percent of the drainage. Of the four Mid-Columbia River tributaries, the effect of irrigation on instream flows is most acute in the Methow (Chapman et al. 1995a). Instream flows limit salmonid production at virtually all stages of the freshwater life cycle. Mullan et al. (1992) assert that a strong hydraulic continuity exists between the Methow River and the groundwater aquifer from river mile 27.5 to 50, and that dewatering of the stream channel between river mile 62 and 74 may be a natural event that is independent of irrigation diversion. They suggest that some irrigation water diverted in summer may return to the river in winter low flow periods through groundwater recharge.

In some areas, forest roads increase fine sediment loading, reduce pool habitat, and reduce access to off-channel habitats. Such roads also directly reduce watershed storage capacity by rapidly routing run-off into stream channels and by compacting floodplain soils, and also indirectly by discouraging beaver pond construction.

Timber harvests have left buffers on fish-bearing streams, but the minimum requirements have not always resulted in adequate shade or large woody debris recruitment.

To protect stream-type chinook salmon, WDFW recently imposed selective resident fishery regulations throughout much of the anadromous fish zone that should significantly reduce incidental juvenile hooking mortality. The recently abandoned practice of planting catchable hatchery rainbow trout in selected areas has probably reduced incidental harvest of chinook salmon and steelhead smolts.

Riparian and Stream Channel Condition

Many channel sections of the Methow River are constrained by rip-rap or channel incision, so that low velocity areas for deposition of fines are limited. Although the effects of surface erosion on salmonid production are not a major concern in the Methow, various actions are currently being considered to mitigate those impacts that do occur. In the Twisp watershed, for example, road obliteration projects are proposed by the Okanogan National Forest for about twenty roads and more spur roads. Similar actions are proposed for the Chewuch watershed.

Boulder Creek watershed, the largest drainage in the Chewuch system, has had several masswasting events in recent history. Significant bank erosion presently occurs in the lower 25 miles of the Chewuch River. Channel downcutting is evident in many parts of this reach, lowering the water table and disconnecting the channel from its floodplain and riparian area.

The peak flow typically occurs from late April to early June and is caused by low elevation snow melt. Low flows occur from September and October, but often the winter flows are lower than that of summer. Up to 90 percent of the water withdrawn from instream flow is used for agricultural irrigation. A total of about 248 cfs is diverted from the Methow River and its tributaries for irrigation, although these values

vary considerably, depending upon total stream flow, time of year, and other factors.

Eggs, yearling salmon and steelhead, and all age classes of trout and char are impacted in low-flow years. Ironically, the areas most susceptible to dewatering by low-flow events are often where the highest densities of spring-run chinook salmon redds and rearing juveniles are found (Hubble and Sexauer 1994). This dewatering appears to be a natural phenomenon, exacerbated by water use for irrigation. The reaches that go dry during low flow years in the Methow watershed expand in length during extreme drought years. In 1992, Ecology completed an instream flow study that identified the following areas as most prone to dewatering:

- between Weeman Bridge and Mazama Bridge, about 1.6 miles;
- between the Early Winters Creek confluence and the Lost River confluence, about 5.5 miles;
- from the Lost River confluence to the Robinson Creek confluence, about 0.9 mile; and
- Libby and Gold Creeks.

Ecology has established instream flow requirements for the Methow watershed (Chapters 173-548 Washington Administrative Code [WAC]). These flows are used to condition new water rights, but do not affect water rights acquired prior to adoption of the instream flow rules.

Mainstem Methow River. In the subbasin plan, the Washington Department of Wildlife (WDW) et al. (1989) state that the upper reaches of the Methow River have a riparian zone that is fairly wide and undisturbed. It has isolated damage from natural events, limited agricultural developments, grazing, logging, and road construction. The middle and lower reaches

appear to have some damage from livestock grazing and agricultural development. However, the quality of substrate in the mainstem Methow is in relatively good condition (Chapman et al. 1994a). Gradient, discharge, and substrate combine to keep accumulations of sediment from occurring in the mainstem (Chapman et al. 1994a). From the confluence of the Chewuch River downstream, the Methow River is in a moderately confined alluvial valley with an average gradient of 0.4 percent.

Chewuch River. While there are some areas in the Chewuch River where habitat is in poor condition, a large portion of the drainage is in very good condition. Stream width-to-depth ratios are relatively high in some reaches. Roughly half the drainage, covering the portions of the watershed north and east of Lake Creek, is relatively undisturbed and functionally intact. However, some areas are deficient in large woody material, mostly due to stream cleanouts for flood control, salvage of instream wood, and extensive stream-channel harvest of potential recruitment trees. Portions of the Lower Chewuch River have been channelized as a result of bank protection efforts after the 1948 flood.

Twisp River. Large woody debris is limited in some sections of the Twisp River, thereby reducing salmonid production. Pool-to-riffle ratios in the Twisp River also indicate a lack of instream cover.

The Relationship of Existing Habitat Conditions to Biological Productivity

Ocean-type Salmonids

It is unclear why the summer-run chinook salmon population in the Methow River is not as robust as those in the Wenatchee and Okanogan Rivers. In general, the condition of spawning gravels in the Lower Methow is considered excellent, as is water quality during the majority of their residence. Mullan et al. (1992) maintain that, historically, the Methow River had smaller runs of summer/fall-run chinook salmon than the

Wentachee and Okanogan Rivers. There is evidence that some subyearlings remain in the Methow River throughout the summer, and emigrate in fall (Chapman et al. 1994a). If a large component of the population remains through summer, they may be impacted somewhat by irrigation water withdrawals. These withdrawals may also reduce adult migration, holding, and spawning habitat (Chapman et al. 1994a), and effectively increase summer water temperatures.

Stream-type Salmonids

The mainstem Methow River and tributaries can be a limiting environment for salmonids during the late summer, when flows are low, and in winter. Stream channel confinement provides adequate depth and cover for salmonids, yet temperature and flow extremes during both summer and winter may cause significant mortality. Based upon analyses of aerial photographs, Chapman et al. (1995a) observed that 6.4 percent of the mainstem Methow River from the Chewuch River confluence downstream to the mouth has extensive placements of rip-rap and 4.1 percent has no riparian vegetation. This lack of riparian coverage would allow significant loss of thermal insulation to the river.

Much of the spawning and early rearing habitat for spring-run chinook salmon lies upstream from irrigation diversions and return flows and is in a permeable glacial deposit. Although not directly influenced by irrigation, some reaches of the Upper Methow and Twisp Rivers are alternately watered and dewatered. Irrigation is known to dewater portions of Gold, Benson, and Beaver Creeks. Flow is much reduced by irrigation in the Lower Twisp River and in Wolf, Goat, and Early Winters Creeks (Chapman et al. 1995a). The effects of irrigation water diversions can be especially severe in drought years. Pre-spawning mortality may also be a significant factor for spring-run chinook salmon in the Methow (Chapman et al. 1995a). Among a myriad of potential causes could be the lack of appropriate cover habitat associated with large woody debris.

Loss of woody debris in the Lower Chewuch and Lower Twisp Rivers may exacerbate the movement of juvenile chinook salmon out of those tributaries in the fall, and into areas that may be less suitable for overwinter holding. Chapman et al. (1995a) believe that fry habitat in the Methow River may be limited, because the river has large segments with unvegetated banks (both eroded and laid-back banks) that would not provide suitable habitat for fry at high flows. Juvenile stream-type salmonids have been documented in lower reaches of smaller tributaries that often go dry in late summer (examples are: Gold, Libby, Beaver, and Wolf Creeks).

Resident Fish

Many of the key habitat factors that apply to anadromous salmonids in the Methow watershed also apply to resident fish. Resident salmonids are found with anadromous fish in many areas but usually reside in smaller order streams with higher gradients. They occur primarily in more forested drainages away from many of the habitat problems associated with bottomland development (bank protection, channelization, water withdrawal). Key habitat conditions for resident fish (in particular rainbow trout, westslope cutthroat trout, and bull trout) revolve around minimizing sedimentation and gravel scouring.

Okanogan Watershed

The Okanogan River originates in British Columbia and flows through several large lake systems before reaching the United States. Most of the following discussion is on that portion within the United States. Migration barriers are an important issue in Okanogan watershed. The Okanogan/Similkameen watershed is the biggest and most complex ecosystem of the four Mid-Columbia River tributaries, and has the largest portion in private ownership. Land use is about equally dominated by forest and rangelands. Despite the extensive private lands, the largest

landowners in the U.S. portion of the basin are USFS and the Colville Tribe. This diverse ownership is a significant factor complicating the management of the resource base in the watershed.

Fish Resources

Warm water and low velocities in the Okanogan River favor non-salmonid fishes. However, the Okanogan River (within the United States) currently supports anadromous runs of chinook salmon, sockeye salmon, and smaller runs of steelhead. Important inland species include mountain whitefish, rainbow trout, and westslope cutthroat trout. The three major evolutionary lifehistory strategies exhibited by salmonids in the watershed are: ocean-type, stream-type, and resident.

Spring-Run Chinook Salmon

There are no indications that spring (stream-type) chinook salmon currently use the Okanogan drainage, but historical records indicate use of three systems: (1) Salmon Creek, prior to construction of the irrigation diversion dam (Craig and Suomela 1941), (2) tributaries upstream of Osoyoos Lake (Chapman et al. 1995a), and (3) possibly Omak Creek (Fulton 1968). There were probably several life-history strategies that historically existed in the Similkameen watershed, prior to construction of Enloe Dam in 1920, although there is no clear evidence that chinook salmon passed the natural falls on the Lower Similkameen River.

Summer/Fall-Run Chinook Salmon

In general, the run strength of summer-run (ocean-type) chinook salmon declined slightly in the Okanogan River over a 20-year period (through the early 1990s) and increased slightly in the Similkameen River, its largest tributary, during this period (Chapman et al. 1994a). Adults enter the Okanogan River from July through late September, with the duration of spawning from late September through early November, peaking in mid-October. The spatial distribution of spawners in the watershed is fairly

discontinuous. Summer-run chinook salmon spawn in limited areas between Zosel Dam and the town of Malott, a distance of about 64 miles. On the Similkameen River, summer-run chinook salmon spawn in the 9-mile span from Enloe Dam to Driscoll Island.

Emergence timing is probably January through April. Juveniles may rear from a few months to a year before migrating downstream. Juveniles generally immigrate to the ocean as subyearling fry, leaving the Okanogan River from 1 to 4 months after emerging from the gravel in April. There is evidence that some fish undergo an extended residence period, with protracted downstream movement. Many subyearlings rear in the Mid-Columbia River reservoirs.

Sockeye Salmon

The run strength of sockeye salmon to Okanogan River is highly variable; escapement has ranged from a low of 1,662 in 1994 to a high of 113,232 in 1967 (estimated from ladder counts after completion of Wells Dam). The 1986 to 1995 average run size is 28,460 fish. Osoyoos Lake is the primary rearing area for sockeye salmon in the Okanogan watershed. The lake is eutrophic and has an abundant food supply, thereby producing relatively large sockeye salmon smolts. Sockeye salmon spawn in the mainstem Okanogan River upstream of Osoyoos Lake, between Lyons Park and McIntyre Dam, a distance of 5 miles, although some may spawn in the reach downstream of Lyons Park and in Vaseaux Creek (Hagen and Grette 1994).

Spawning occurs from early October through early November, with the peak in mid-October. Adult passage through Lower Okanogan River (downstream of Osoyoos Lake) may be blocked, in certain years, by warm water conditions during late July and early August (Pratt et al. 1991). Reconstruction of Zosel Dam in 1987 improved passage conditions into the lake. Sockeye salmon probably exhibited three general historical lifehistory strategies (anadromous sockeye, residual sockeye, and resident kokanee). All three groups

appear to be closely related genetically and some hybridization likely occurs between the groups. However, the mechanism for the expression of these different life-history strategies is not well understood.

Steelhead

Very few wild steelhead currently use the Okanogan River. The historical record for steelhead in the Okanogan watershed is not complete, yet Mullan et al. (1992) assert that very few steelhead historically used Okanogan River. Salmon and Omak Creeks probably had small runs of steelhead, but passage barriers have restricted access to each stream. Steelhead may have historically used some tributaries upstream of Osoyoos Lake (Chapman et al. 1994b). Current habitat conditions in the migration corridor are poor for most, if not all, steelhead life-history types.

Resident Salmonids

Rainbow trout appear to have one life-history pattern; to spawn and rear in the upper tributaries, including the Upper Toats Coulee, and the Salmon, Omak, Sinlahekin, Bonaparte, and Tonaset Creeks. The population size and distribution of rainbow trout in these streams are not known.

The status of bull trout in the Okanogan watershed is unknown, but they are believed to be extinct downstream of Enloe and Zosel dams. Salmon and Loup Loup Creeks supported bull trout populations; however, hybridization with introduced brook trout may have caused a functional extinction of these populations. In a recent radio-tagged study, none of the 39 tagged bull trout entered the Okanogan River (BioAnalysts, Inc. 2002).

The status of cutthroat trout in the Okanogan watershed is relatively unknown. Cutthroat have been detected in the upper reaches of North Fork Salmon Creek, however it is not known whether these fish are native westslope cutthroat trout or an introduced subspecies. Historical records

indicate the presence of cutthroat in the Middle Fork Toats Coulee. It is speculated that the existing cutthroat trout are not native to the Okanogan watershed; those currently present in Toats Coulee (and possibly Salmon Creek) may have been planted.

Habitat Conditions

The average annual flow for Okanogan River, measured at Ellisforde, is about 3,200 cfs, which is highest of the four watersheds considered in this assessment. About 75 percent of the flow comes from its largest tributary, the Similkameen River, which lies mostly in Canada. Upstream of the Similkameen confluence, the Okanogan flows through six large lakes—five of which are inaccessible to anadromous salmonids and are entirely in Canada. Osoyoos Lake lies both in Canada and the United States and is used by sockeye salmon. The Wells Project boundary includes the lower 11 miles of the Okanogan River.

Stream habitat conditions are fair to good in the Okanogan National Forest, and sediment delivery from this forest to lower reaches is not a significant problem. However, the lack of overhead cover, woody debris recruitment, invertebrate drift, undercut banks, and stream bank stability are common in the Lower Okanogan River because of limited riparian vegetation in the lower river.

In the mainstem Okanogan River in British Columbia, there are 13 vertical drop structures between Osoyoos Lake and Vaseaux Lake. These structures regulate water flow for flood control and irrigation purposes, and are spaced at roughly 0.6-mile intervals. McIntyre Dam is 4.85 miles upstream of the furthest upstream structure (Vertical Drop Structure 13), and is a barrier to adult sockeye salmon migration, although some adults have been known to pass the dam in high water years. These structures limit the spawning distribution of sockeye salmon. Flow regulation emanating from Skaha Dam and Okanogan Falls Dam are partially responsible for dewatering

sockeye salmon redds in the Upper Okanogan Basin. The reach between Vertical Drop Structure 13 and McIntyre Dam is where the majority of sockeye salmon spawn. Some sockeye salmon also spawn in Vaseaux Creek (0.9 mile below McIntyre Dam) and in the mainstem Okanogan River between Vertical Drop Structure 13 and Vertical Drop Structure 3 (6.4 miles). In low water years, passage into Vaseaux Creek may be blocked (Hansen 1993).

Zosel Dam (river mile 78) controls the level of Osovoos Lake. Releases of water from Zosel Dam and others in the British Columbia reaches of the Okanogan River affect passage of salmonids and water quality conditions in the Lower Okanogan River. Enloe Dam, located at river mile 9.5 on the Similkameen River, blocks anadromous fish passage. However, there is evidence from historical records (FERC 1980) and affidavits by the Upper Similkameen Indian Band that anadromous salmonids were blocked from upstream passage by a falls on the Lower Similkameen River, which is now inundated by Enloe Dam. These records suggest that anadromous salmonids were not native to the Upper Similkameen watershed.

Flows in Lower Okanogan River are regulated by the series of dams in British Columbia and Zosel Dam. Water releases to meet fishery needs are negotiated yearly by a consortium of fisheries and irrigation managers from both Canada and United States. During sockeye salmon spawning, water flow from the Upper Okanogan River into Osoyoos Lake is generally between 250 and 380 cfs. However, extreme flow fluctuations have occurred in the river during and after completion of spawning, resulting in both redd scouring and dewatering. Douglas County PUD (in cooperation with British Columbian fish, Tribal and water management agencies) is pursuing an aggressive set of flow monitoring, prediction and control measures that will reduce the amount of scour and dewatering that affects the sockeye salmon populations in the upper reaches of the Okanogan River Basin. In 1976 Ecology

established base flows for Okanogan River (WAC 173-549; Table 19), and ruled that no further appropriation of surface water shall be made from Okanogan River and tributaries which would conflict with these base flows. Ecology has established instream flow requirements for the Okanogan watershed (Chapters 173-549 WAC). These flows are used to condition new water rights, but do not affect water rights acquired prior to adoption of the instream flow rules.

Water temperatures often exceed lethal tolerance levels for salmonids in the Lower Okanogan River. These temperature exceedances are partly a result of natural phenomena (low gradient and solar radiation on the upstream lakes). However, the condition is exacerbated by the thermal absorption of the surface waters in the six lakes in this drainage, the lack of functional riparian zones along large segments of the lower river, the presence of excessive amounts of sediment originating from the Similkameen River and low summer flows caused by upstream dam operations and irrigation. High water temperatures in late summer and fall effectively exclude juvenile salmonids from rearing in most of the basin, except the first few weeks after emergence. However, some limited summer rearing may occur in the Similkameen River where ground water enters the stream. At times, high water temperatures in the Lower Okanogan River have blocked adult anadromous salmonid passage.

Omak Creek

The Colville Tribe collaborated with Natural Resources Conservation Service to develop a watershed plan and environmental assessment for Omak Creek (watershed size is 90,700 acres). This stream is significant to the Colville Tribe, as it is the only watershed that lies solely within the reservation. The goals of the plan are to restore over 37 miles of steelhead habitat by improving water quality, reducing soil erosion, reducing water temperatures, and eliminating man-made barriers. This last task, removal of a "velocity"

barrier" through a large culvert under the Omak Wood Products mill at the mouth of the creek, is the single most important means to restore natural production in Omak Creek.

Low flows (at times less than 1 cfs at the mouth) also appear to limit the production capabilities in Omak Creek. However, flows could be increased substantially if some of the water diversions are addressed. Likewise, there would be other benefits to sensitive species, and the potential for increased flows when some of the upland rehabilitation practices are implemented.

Salmon Creek

In 1916, a diversion dam was built on Salmon Creek for irrigation of about 3,000 acres of orchard and crop land. The dam, located at river mile 3, diverts all water into a 7.5 mile long ditch, which provides gravity fed irrigation water to about 300 users. The lower 3 miles of Salmon Creek is dewatered, except when excess water overflows the diversion dam during spring freshets. At other times, some groundwater surfaces into reaches of the dewatered channel, but not enough to support most aquatic biota.

The Okanogan Irrigation District manages the water supply to the irrigation ditch through controlled releases from two reservoirs:

Conconully Lake and Conconully reservoir. The former feeds the latter, and both systems regulate the flows into Lower Salmon Creek. From Lower Conconully reservoir, Salmon Creek flows through about 12.5 miles of public and private lands before it is diverted into the irrigation channel. There is no upstream passage structure on either dam or the diversion structure. Kokanee and resident rainbow trout naturally reproduce in the two reservoirs, and support a local sports fishery.

Omak Fish Hatchery (managed by WDFW) plants catchable-size rainbow trout in these lakes. Historical records indicate bull trout were present in the North Fork Salmon Creek. In years of poor water supply from the reservoirs, the Okanogan

Irrigation District pumps up to 30 cfs of water from Okanogan River near Omak to supplement the irrigation channel. This measure is done only in extreme situations, because the electrical power costs are high. Likewise, maintenance costs for the impellers are high, because of the high silt load in the Okanogan River. The life span of impellers under normal load is 1 year.

Upstream of the irrigation diversion dam (river mile 3), the average flow in Salmon Creek is 49 cfs, which could provide substantial habitat for salmon and steelhead. Habitat and water conditions upstream of the irrigation diversion dam are in fair to very good condition, depending upon the reach. Water temperatures are suitable for all stages of salmonid life history. There are numerous affidavits from early settlers of salmon and steelhead in this stream prior to dam construction. Currently, adult steelhead have been observed in the lower reach of Salmon Creek when water flows to the Okanogan River confluence.

Some entities have proposed to renovate the diversion dam to provide water to Lower Salmon Creek. This would require installation of a passage structure at the diversion dam and substantial changes to the irrigation system. Additionally, if sockeye salmon were to be introduced to the system, a passage structure at the landfill dam on Conconully reservoir would be required. The Okanogan Irrigation District is evaluating modifications to the current system to provide additional water to the lower reach of Salmon Creek.

Mainstem Okanogan River

The riparian habitat in the Okanogan is the most degraded of the four primary watersheds in the Mid-Columbia River (Chapman et al. 1994b). This lack of riparian vegetation contributes to the two major limiting factors, high water temperatures and sedimentation. Likewise, the instream habitat has the most limitations to salmonid production. Establishment of riparian and instream habitat would have limited benefits

after mid-summer, because of high water temperatures emanating from the six storage lakes in this system. Spawning gravels are severely limited in the mainstem Okanogan River because of sedimentation. Heavy silt loads from mass failures have caused fine sediment to infiltrate redds and smother habitat for invertebrates in the Similkameen and Lower Okanogan Rivers. High turbidity in these reaches also reduces the feeding efficiency of juveniles.

Similkameen River

Historically, the Similkameen River was estimated to contain about 4,300 acre-feet of spawning substrate, 80 percent of the total for the Okanogan watershed (Chapman et al. 1994b). Half of this habitat was estimated to lie between Palmer Creek and Keremeos, BC (USFWS 1985). Only the lowest 9 miles of the Similkameen River is currently available to salmonids because of Enloe Dam. However, there is some evidence that this was the upstream extent of historical anadromous fish habitat due to a reportedly impassible falls that was inundated by the dam. Some of the highest densities of summer-run chinook salmon redds in the Mid-Columbia River region have been documented in this reach of the Similkameen River (Hillman and Ross 1992).

The Similkameen River provides 75 percent of the average flows to the Okanogan Basin. Like the Upper Okanogan River, the Similkameen has high summer temperatures, often up to 72° F (22° C) (Chapman et al. 1994b). As such, the Lower Similkameen cannot support summer rearing by juvenile salmonids.

Osoyoos Lake

Osoyoos Lake is 8 miles long and relatively shallow. Although the maximum depth is about 200 feet, much of the lake is less than 100 feet deep. It is very warm in the summer months, highly polluted, and appears to be in the transitory state leading to complete eutrophication (Allen and Meekin 1980). Unlike Lake Wenatchee (the other principle sockeye salmon rearing area in the

Mid-Columbia River region), Osoyoos Lake is characteristic of eutrophic lakes (Mullan 1986) with shallow, warm water enriched by agricultural influences (Allen and Meekin 1980).

Osoyoos Lake is the primary rearing area for juvenile sockeye salmon in the Okanogan River system. Osoyoos Lake has a relatively abundant food source, consequently producing relatively large sockeye salmon smolts (Mullan 1986). Predators, warm water temperatures, and anoxic hypolimnetic areas may limit sockeye salmon production in the lake (Pratt et al. 1991). Eighteen species of fish inhabit the lake, and many are potential sockeye salmon predators (Chapman et al. 1995b). Water temperatures rise early in the year, reaching 64° F (18° C) at the surface of the lake as early as May. In August, surface temperatures reach 77° F (25° C) (Allen and Meekin 1980).

Other Lakes

There are several lakes (over 25 acres in size) in the Okanogan watershed that are currently, or were historically, blocked to anadromous fish passage. Omak Lake is a large, oligotrophic, deep alkaline lake with a high concentration of dissolved substances typical of the hard-water lakes of eastern Washington. Conductivity is generally high, and the water has high clarity and high dissolved oxygen levels. Conconully, Palmer, and Spectacle Lakes generally have good water quality, although algae blooms have occasionally been observed (Ecology 1976).

The Relationship of Existing Habitat Conditions to Biological Productivity

Water temperatures pose the most difficult problem for increasing survival of both ocean-type and stream-type salmonids. Chapman et al. (1994a) plotted water temperature in the Okanogan River at Oroville and Tonasket, showing that mean daily temperatures were frequently well over 70° F (21° C) in 1986 and 1987 in mid-summer when sockeye salmon could be expected to migrate upstream. Hansen (1993) plotted mean daily temperatures near Zosel Dam

at 70° F or higher for at least 50 days in 1992, and higher than 77° F (25° C) for periods of up to 10 days. He also documented that temperatures upstream from Osoyoos Lake remained higher than 70° F for many days in July and August. Hansen (1993) speculated that the alteration of flow regimes by upstream structures have possibly changed retention times in Osoyoos Lake that exacerbate the problem.

Ocean-type Salmonids

The high temperatures in the Lower Okanogan River could force ocean-type chinook salmon subyearlings to remain well upstream in cooler areas or leave the Okanogan watershed for the Columbia River before the high temperatures begin to develop. Spawning habitat for ocean-type chinook salmon is highly degraded, but still supports a viable population. Progeny of chinook salmon spawners in the Similkameen River must emigrate as subyearlings to maintain viability.

Stream-type Salmonids

Sockeye salmon production is limited by spawning habitat (Allen and Meekin 1980; Mullan 1986; Chapman et al. 1995b), and flow

conditions in the Lower Okanogan River (downstream of Osoyoos Lake) as well as related elevated temperatures in the lake and river have been shown to adversely affect adult survival. The estimated carrying capacity is about 4 million smolts, substantially higher than the current production (from 0.5 million to 2.0 million) (Pratt et al. 1991).

Predators, warm water temperatures, and anoxic hypolimnetic areas may limit sockeye salmon production in Osoyoos Lake (Pratt et al. 1991). Recent dissolved oxygen and temperature profiles of Osoyoos Lake (Rector 1993) indicate the formation of a strong thermocline in summer months that persists until fall turnover. Thermoclines of this magnitude result in large portions of the lake not being conducive for rearing of sockeye salmon fry and limit its rearing capacity (Pratt et al. 1991).

Correcting fish passage problems in Salmon and Omak Creeks would substantially increase the production capabilities of the system for springrun chinook salmon and steelhead compared to existing conditions.

3.3 WATER RESOURCES (QUANTITY AND QUALITY)

Key Terms

- **303(d)** List A list of water bodies that Ecology has identified as having impaired water quality based on evidence that specific water quality standards have not been met. Section 303(d) of the Federal Clean Water Act requires that states prepare and periodically update these lists and develop controls to bring the water bodies into compliance with standards and protect beneficial water uses (e.g., water supply, cold-water fisheries). Hundreds of creeks and river segments in Washington are currently on the 303(d) list.
- **Base Flow** The normal low flow that occurs seasonally in a river or creek. During a period of run-off from rain or snowmelt, streams rise above base flow levels and then recede to base flows sometime after the run-off event has passed. Base flows are sustained by groundwater discharges that may vary seasonally (e.g., higher base flow in the spring and lower in the summer).
- **Dissolved Oxygen** The amount of oxygen that is in solution. Compared to warm-water fish (e.g., largemouth bass or catfish), cold-water fish (e.g., salmon and trout) require relatively high levels of oxygen for respiration. Water quality standards for dissolved oxygen are minimum concentrations to protect cold-water fisheries.
- **Flow** (or **Discharge**) A measurable quantity of water passing through a dam or a reach of river over a given period of time. Flows for rivers in the United States are commonly reported in cfs.
- **Instream Flow** The amount of water in a river or creek required to sustain fisheries and water quality needs. Fisheries biologists and hydrologists have developed a model called the "instream flow incremental methodology," which is applied to streams to determine the optimum flows needed for fish habitat.

Key Terms (continued)

- **Run-of-the-River Hydroelectric Project** The Wells, Rocky Reach, and Rock Island hydroelectric projects are run-of-the river projects, which means that they do not store substantial amounts of water in their reservoirs. Run-of-the-river hydroelectric projects produce electric power through use of the gravitational force of falling water; they consist of a powerhouse, spillway, and embankments, and may also include fish passage facilities.
- **Total Dissolved Gas** Total dissolved gas is the amount of all gases that are in solution (e.g., nitrogen, carbon dioxide, oxygen). "Supersaturation" occurs when water is aerated to the degree that dissolved gases in the water exceed equilibrium conditions for saturation. High levels of supersaturation are harmful to fish; therefore, water quality standards for total dissolved gas are maximum concentrations.
- **Tributaries** Smaller streams or rivers that enter larger water bodies. For example, the Wenatchee River is a tributary of the Columbia River, and Icicle Creek is a tributary of the Wenatchee River.
- **Turbidity** A measure of the cloudiness or opaqueness of water. In other words, muddy water has high turbidity and clear water has low turbidity. Turbidity is measured by an instrument that passes a beam of light through a water sample and measures the degree to which the light is scattered by suspended particles.
- Water Quality Standards These standards define the minimum requirements to protect beneficial uses of rivers, creeks, lakes, and other water bodies and are required by the Federal Clean Water Act for all states to establish and enforce. The current Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201A of the Washington Administrative Code) designate water bodies as "Class AA" (extraordinary), "Class A" (excellent), or other classes. Each class has numerical and narrative standards to protect general beneficial uses, with Class AA having the most stringent standards. In the future, the standards will be changed to identify specific beneficial uses for each water body. Similar to State standards, Tribes administer water quality standards on their lands.
- Water Rights Water rights permits are required from Ecology to withdraw water from rivers, creeks, lakes, or groundwater resources. These permits specify where, when, and how much water may be withdrawn. In many areas of the State, water rights have been over-allocated to the point that there is not enough water to both meet the demands of water rights applicants and sustain water quality and fisheries needs.
- * See Chapter 7 for a complete listing of all Key Terms.

3.3.1 WATER QUANTITY

Water quantities in the Mid-Columbia River and its tributaries are important to fish, wildlife, and people. The salmonid life cycles are closely tied to the annual water cycle, with juvenile outmigration occurring during spring high flows. High flows help the young fish reach the Pacific Ocean quickly, thereby minimizing predation and other causes of mortality in the river. Maintaining adequate summer low flows is also critical to the success of salmon and steelhead spawning and rearing in small tributary channels.

3.3.1.1 Project Area

The Columbia River is primarily fed by snowmelt. Snow accumulates in the higher elevations from fall through early spring, then melts producing run-off during late spring and summer. High run-off occurs when the snow is melting during May and June, with streamflows typically reaching their peaks in early June. These high flows are critical to the efficient outmigration of juvenile salmonids. In late summer and fall, the river flows recede and generally remain low through April. Rainfall occasionally increases the run-off, and rain-on-snow events have caused some of the largest floods in the Mid-Columbia River.

Columbia River Basin hydropower projects fall into two major categories: storage and run-of-the-river. Storage projects such as Grand Coulee Dam have a large operating range between minimum and maximum pool elevations, store large volumes of run-off water and shape downstream flows by gradually releasing the stored water.

The releases from Grand Coulee Dam and regulation by Chief Joseph Dam fundamentally affect the magnitude and timing of flows at downstream run-of-the-river dams. Since Grand Coulee Dam is not equipped with selective depth-withdrawal facilities, downstream water temperatures depend on the depth of the Lake Roosevelt thermocline.

Operating plans for the storage facilities are implemented by Federal agencies according to the Columbia River Treaty with Canada. Grand Coulee releases water from August through December to meet energy demands, draws down the reservoir from January through mid-April for flood control and power production, and refills the reservoir from mid-April through June. Beginning in 1983, water was also released in the spring to aid downstream migration of juvenile anadromous salmonids.

The Mid-Columbia River dams and other run-ofthe-river projects have a small operating range, little storage capacity, and must pass inflow through the reservoirs most of the time. The utility districts record daily measurements of the water quantity or flow passing each of these dams.

Wells Dam

Douglas County PUD records daily measurements of flow through turbines plus spillway flow, when present, at Wells Dam. Average flows between 1980 and 1997 ranged from 75,151 cfs in September to 138,946 cfs in June (Figure 3-6) (Ecology 2000). A maximum discharge of 402,000 cfs was reported for June 15, 1972.

Wells Dam has a somewhat broader range of normal pool elevations ranging from 771 to 781 feet than the other Mid-Columbia River projects. The existing FERC license allows a minimum elevation of 767 feet, if requested by the Army Corps of Engineers for flood control, and a maximum pool elevation of 791 feet during a

"flood of record" spill event (Beak Consultants, Inc. 1996). The most recent license settlement agreement includes criteria for spill bypass operations to enhance juvenile fish passage (FERC 1991).

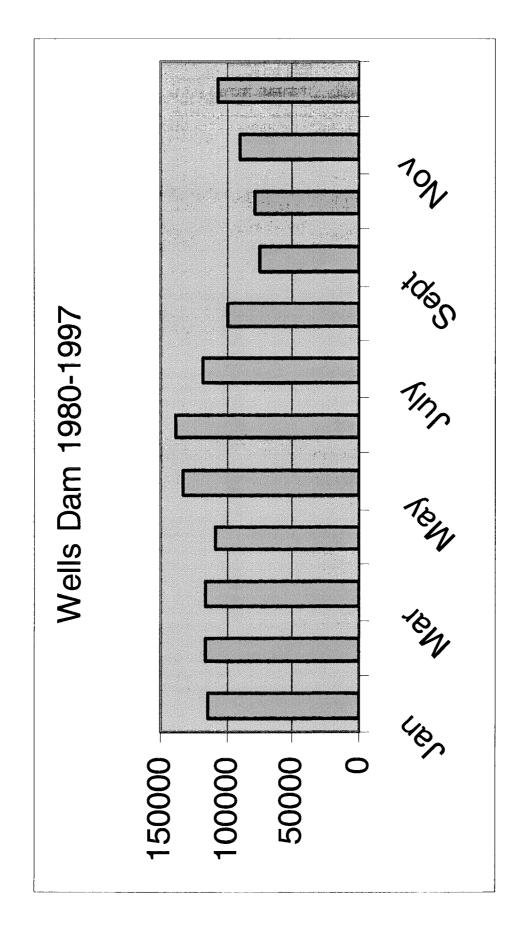
Rocky Reach Dam

Similar to Rock Island Dam, Chelan County PUD records daily measurements of flow through the turbines plus spillway flow, when present (Wiggins et al. 1997). These measurements have been recorded continuously since October 1960. Average flows between 1980 and 1997 ranged from 76,821 cfs in September to 157,553 cfs in June (Figure 3-7) (Ecology 2000). A maximum discharge of about 535,000 cfs was reported for June 10, 1961. These measurements are a requirement of the original FERC license for Rocky Reach (FERC 1957a).

Similar to Rock Island, Rocky Reach Dam normally fluctuates the forebay elevation only 4 feet (i.e., 703 to 707 feet elevation) with a maximum range from 703 to 710 feet (FERC 1957a).

Rock Island Dam

Since June 1961, Columbia River discharge has been measured daily by Chelan County PUD at Rock Island Dam as the flow through turbines plus spillway flow, when present (Wiggins et al. 1997). Previous measurements were limited to water level records. Average flows between 1980 and 1997 ranged from 76,478 cfs for September to 162,228 cfs for June (Figure 3-8) (Ecology 2000). A maximum discharge of 692,600 cfs was recorded for June 12, 1948 (Wiggins et al. 1997). From flood marks at Wenatchee, Washington, the flood of June 7, 1894, was estimated to have reached a peak discharge of 740,000 cfs. The minimum recorded flow is 4,120 cfs from February 10, 1932 (FERC 1988).

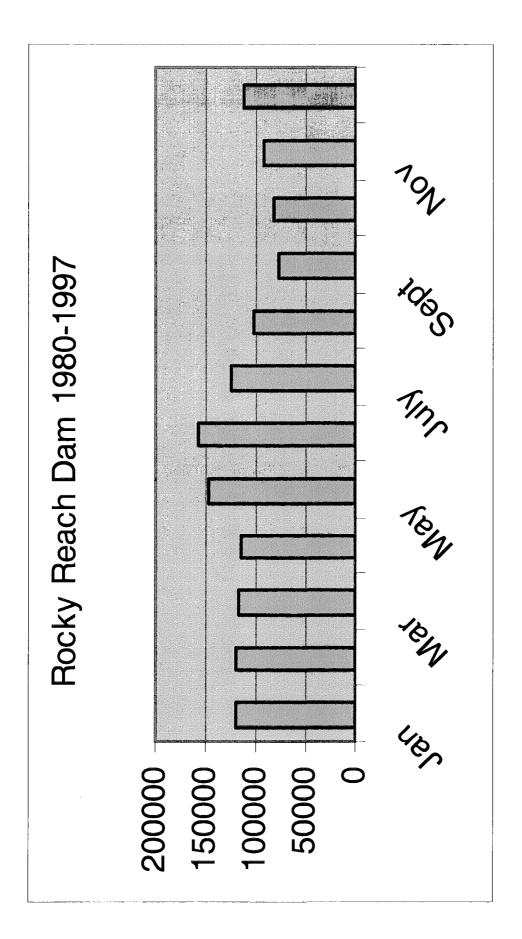


FEIS for the Wells, Rocky Reach, and Rock Island HCPs

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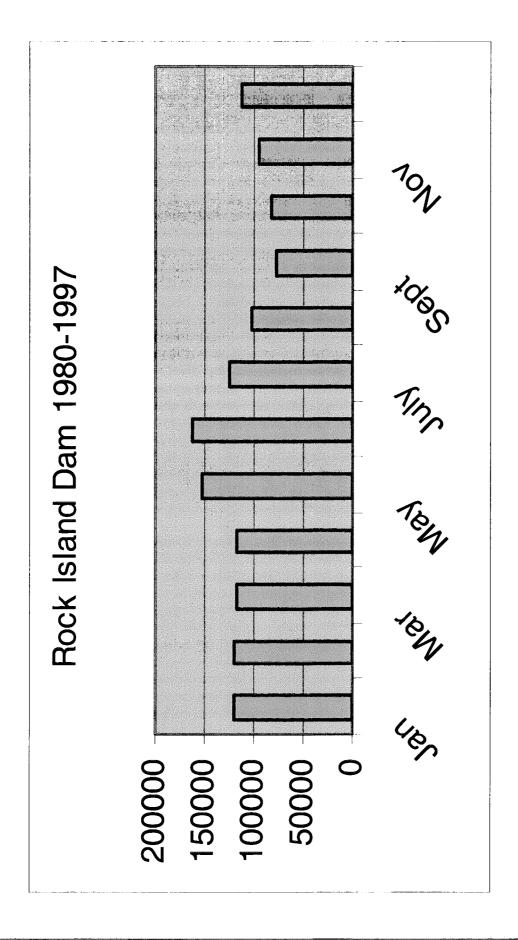


Figure 3-8
Average Monthly Flow (cfs) in the Mid-Columbia River at Rock Island Dam

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As a run-of-the-river project, the Rock Island Dam has very limited capabilities for raising and lowering reservoir water levels. Forebay water levels generally fluctuate between 609 and 614.1 feet elevation, with a maximum range of 602.9 to 619.5 feet (FERC 1989a). The normal operating range is only exceeded during unusual circumstances (e.g., if spill requirements exceeded reservoir inflows for an extended time period).

3.3.1.2 Associated Tributaries

The USGS operates stream-gauging stations on the Wenatchee, Entiat, Methow, and Okanogan Rivers and some of their tributaries. The relatively arid conditions in watersheds on the east side of the Cascade range, combined with the demand for water supplies for irrigation and other uses, result in low flows that affect fish in many of these streams.

Using instream flow incremental methods and data from other hydrologic studies, Ecology has determined that beneficial uses (i.e., fisheries) of many Mid-Columbia River tributaries are impaired due to insufficient instream flows.

To comply with Section 303(d) of the Clean Water Act, Ecology has placed these tributaries on a list of impaired water bodies (i.e., the 303[d] list) and is developing controls to restore beneficial uses (Ecology 1998a). The latest 303(d) list for the State of Washington was updated by Ecology in 1998 and submitted to the USEPA for approval. As part of the response to critical low flows in Mid-Columbia River tributaries, Ecology is not permitting new water rights to withdraw water from several of the Mid-Columbia River tributaries.

Fish hatcheries and other artificial propagation facilities associated with the Mid-Columbia River and its tributaries withdraw water from the rivers primarily for non-consumptive uses. The water is returned close to the point of withdrawal so these

facilities have a negligible effect on instream flows.

Wenatchee River

The Wenatchee River flows from the east slope of the Cascade Mountains in Chelan County and enters the Columbia River approximately 6 miles downstream from the Rocky Reach Dam (see Figure 1-3). The Wenatchee River watershed drains 1,328 square miles with 231 miles of major streams (NMFS et al. 1998b). Major tributaries include the Little Wenatchee, White, and Chiwawa Rivers; and Nason, Icicle, Chumstick, and Peshastin Creeks.

Although the Wenatchee River watershed is only the third largest of the four major Mid-Columbia River tributaries, it produces the greatest average annual discharge (2.3 million acre-feet [NMFS et al. 1998b]). Average monthly flows range from less than 836 cfs in September to more than 9,043 cfs in June (Figure 3-9) (Wiggins et al. 1997). Snowmelt is the primary source of the high flows seen in late spring and early summer. However, the maximum recorded discharge for the Wenatchee River (47,500 cfs) occurred on November 30, 1995, in response to a rain-onsnow event (Williams and Pearson 1985). Effects of the large forest fires of 1994, including reduced evapotranspiration and soil absorption capacity, likely contributed to this high peak flow, and may continue to increase total river discharge for an undetermined time (Wenatchee River Watershed Steering Committee/Technical Advisory Committee 1996). In dry years, September flows have averaged as low as 346 cfs.

Of the 420 cfs total water rights established in the Wenatchee River watershed, irrigation districts own about 68 percent (NMFS et al. 1998b). Other water uses are domestic (10 percent), commercial and industrial (8 percent), municipal (6 percent), fish hatcheries (3 percent), and others (4 percent). There are four major irrigation districts in the Wenatchee River watershed: (1) Wenatchee Reclamation District, (2) Icicle and

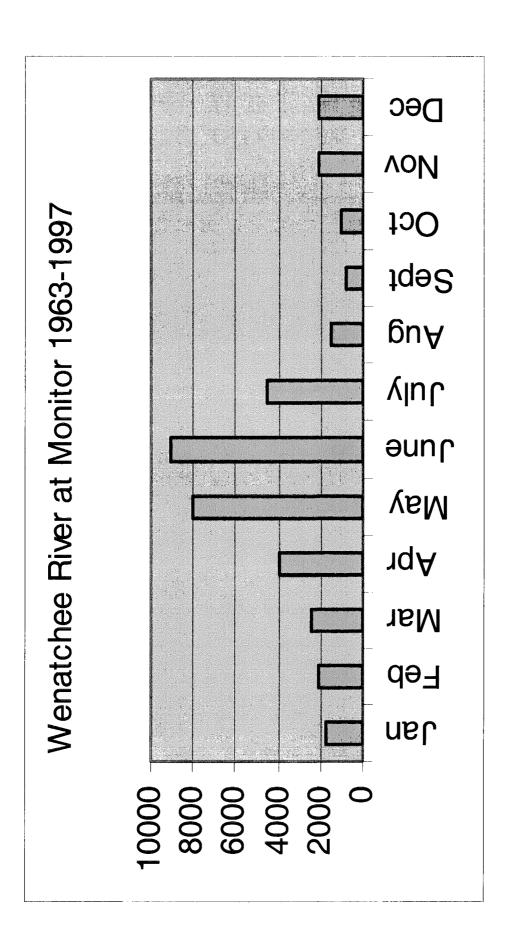


Figure 3-9
Average Monthly Flow in the Wenatchee River at Monitor, Washington

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Peshastin Irrigation Districts, (3) Cascade Irrigation District, and (4) Chiwawa Irrigation District, together with two smaller irrigation groups (Jones-Shotwell and Pioneer-Gunn). Wenatchee Reclamation District, the largest user, diverts up to 200 cfs from the Wenatchee River at Dryden.

Ecology established minimum instream flows for the Wenatchee River and some of its tributaries, to protect and preserve instream values, such as fish and wildlife habitats (NMFS et al. 1998b). These flows are used to condition new water rights issued by Ecology. Because data indicate that minimum instream flow requirements (e.g., 1,200 cfs at Peshastin and 2,000 cfs at Monitor) are not met 90 percent of the time from August to October, Ecology placed the Wenatchee River on its 303(d) list as impaired due to inadequate instream flows (Ecology 1998a). In years of low snowpack, water withdrawals for irrigation and other uses may affect salmonid spawning and rearing habitat.

Several tributaries of the Wenatchee River have also been placed on the 303(d) list as impaired due to inadequate instream flows (Ecology 1998a). Icicle Creek instream flow requirements are not met for an average of 66 days from August to October due to water withdrawals for irrigation, the Leavenworth Fish Hatchery, and the town of Leavenworth. Measurements of essentially zero flow in Chumstick Creek were attributed to large irrigation diversions. Existing water right users, such as the Peshastin Irrigation District, divert enough water to dry up Peshastin Creek in late summer and early fall. Similarly, diversions from Mission Creek were deemed responsible for the lack of flows in Mission Creek. Ecology is responsible for developing controls that restore habitat for spring-run chinook salmon and steelhead in these streams.

Entiat River

The Entiat River flows between the Entiat and Chelan Mountains on the east slope of the

Cascade Range in Chelan County, and joins the Columbia River 10 miles upstream from Rocky Reach Dam. The Entiat River watershed drains 419 square miles (Williams and Pearson 1985). Approximately one-fourth of this area is the Mad River watershed, the only major tributary of the Entiat River.

The Entiat River watershed is the smallest of the four major Mid-Columbia River tributaries addressed in the HCP. Average monthly flows in the lower river near Entiat River, are 115 cfs in September and more than 1,430 cfs in June (Figure 3-10) (Wiggins et al. 1997). Snowmelt is the primary source of the high flows seen in late spring and early summer. A maximum discharge of 6,430 cfs was recorded at the Upper Entiat River gauging station on June 10, 1972 (Williams and Pearson 1985), and the maximum flow in the lower river likely exceeded 8,000 cfs at that time.³ In dry years, monthly flows have averaged as low as 60 cfs (Wiggins et al. 1997).

Methow River

The Methow River originates in the Okanogan National Forest and Pasayten Wilderness on the east slope of the Cascade Range in Okanogan County, and flows southeast to the Columbia River at Pateros, Washington (see Figure 1-5). The Methow River watershed drains 1,792 square miles. Two major tributary watersheds, the 245-square-mile Twisp River watershed and the 525-square-mile Chewuch River (formerly named the Chewack River) watershed (Wiggins et al. 1997) encompass more than 40 percent of this area.

Average monthly flows in the Methow River near Pateros, Washington are 453 cfs in September and 5,963 cfs in June (Figure 3-11) (Wiggins et al. 1997). Similar to the other major Mid-Columbia River tributaries, snowmelt is the

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³ Flow gauging in the lower Entiat River was discontinued between 1958 and 1996; thus, the maximum flow during the 1972 peak was estimated. Average monthly flows for the lower Entiat River are based on the records for 23 years between 1911 and 1958.

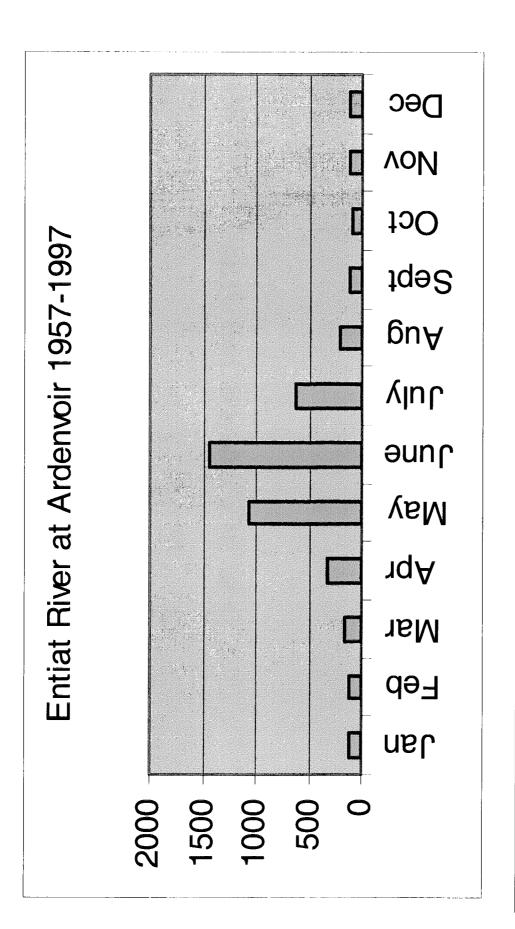
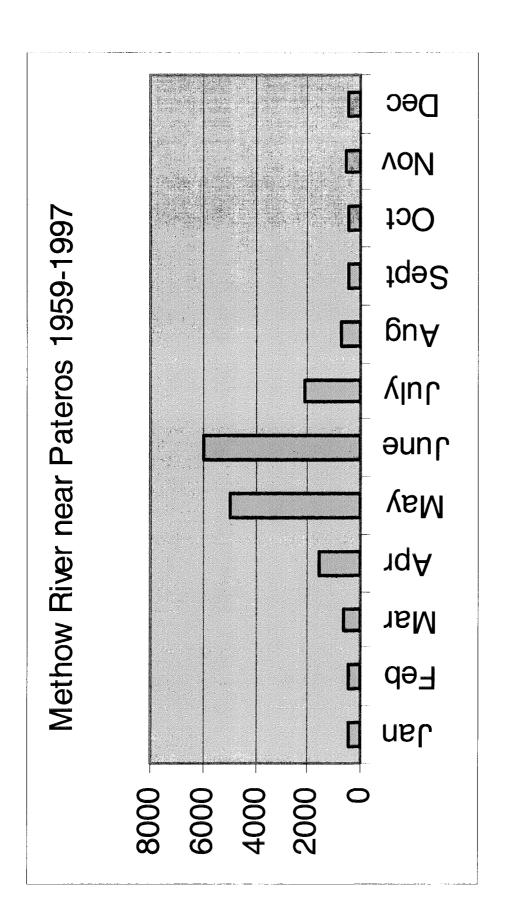


Figure 3-10 Average Monthly Flow in the Entiat River at Entiat, Washington

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primary source of the high flows seen in late spring and early summer. The maximum measured discharge was 28,800 cfs in May 31, 1972; however, a peak discharge of 46,700 cfs was estimated for May 29, 1948 (Williams and Pearson 1985). In dry years, monthly flows have averaged as low as 237 cfs (Wiggins et al. 1997).

Ecology found that instream flows limit salmonid production in the Methow River and its tributaries at virtually all freshwater stages of their life cycle (Caldwell and Catterson 1992). Therefore, Ecology placed four reaches of the Methow, Twisp, and Chewuch Rivers, and Beaver, Early Winters, and Wolf Creeks on the 303(d) list of water quality limited streams because of low instream flows. Ecology also established instream flow requirements for the Methow River watershed to limit any new water rights (NMFS et al. 1998b).

Although only 6 percent of the Methow River watershed is private property, including 12,800 acres of irrigated cropland (NMFS et al. 1998b), the effect of irrigation on instream flows is considered more acute than in other Mid-Columbia River tributaries (Methow Valley Water Pilot Planning Project Committee 1994). Up to 90 percent of instream flow withdrawals (248.2 cfs) are used for agricultural irrigation (NMFS et al. 1998b). Ecology estimated that ditches remove about 50 percent of the river flow from the Methow River and most of the flow from some tributaries, in late summer and fall. In summary, hydrologic studies suggest that irrigation diversions exacerbate the problem of critically low flows that occurs naturally in the Methow River watershed.

Okanogan River

The Okanogan River originates in British Columbia, flows through several large lakes, and enters the Columbia River approximately 11 miles downstream from Chief Joseph Dam (see Figure 1-5). The largest of the Mid-Columbia River tributaries, the Okanogan River drains a

watershed of approximately 8,080 square miles (Wiggins et al. 1997). Approximately one-half of this area lies within the Similkameen River watershed, an international river system that joins the Okanogan about 5 miles downstream from Osoyoos Lake and supplies approximately 75 percent of the Okanogan River flow below the confluence.

Flows in the Lower Okanogan River are partly regulated by water releases from Zosel Dam and other dams in British Columbia. These releases are negotiated yearly by an international consortium of fisheries and irrigation managers (NMFS et al. 1998b). Although water flows from the Upper Okanogan River into Osoyoos Lake are generally maintained between 250 and 380 cfs during sockeye salmon spawning, extreme flow fluctuations after spawning have resulted in both redd scouring and dewatering.

Average monthly flows in the Lower Okanogan River at Malott, Washington, are 1,203 cfs in September and 10,330 cfs in June (Figure 3-12) (Wiggins et al. 1997). Snowmelt is the primary source of the high flows seen in late spring and early summer. The maximum discharge was 45,600 cfs on June 3, 1972. In dry years, monthly flows at Malott have averaged as low as 372 cfs in September (Wiggins et al. 1997).

In 1976, Ecology established base flows for the Okanogan River, and ruled that no further appropriation of surface water from the river and its tributaries shall be made which would conflict with these base flows (NMFS et al. 1998a). They further determined that, except for livestock watering and domestic uses, no additional appropriations of water from lakes would be granted. Lower Okanogan River flows drop below the minimum base flows established for late August and September (i.e., 800 cfs), during dry years.

Salmon Creek, a tributary that enters the river at Okanogan, Washington, was placed on the 303(d) list as impaired due to inadequate instream flows.

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In making this determination, Ecology cited studies showing that irrigation diversions can completely dry up the creek and flow can be zero from February to September, resulting in the total loss of salmon and steelhead runs in the stream.

3.3.1.3 Columbia River System

The Columbia River system drains an area of 259,000 square miles (FERC 1996b). The three project area dams form run-of-the-river reservoirs that have a limited effect on river flows compared to several upstream dams that are operated, in part, for flood control. Wells, Rocky Reach, and Rock Island dams are relatively low dams that were designed for hydropower production and have very little capacity to impound water for flood control. Chief Joseph Dam, immediately upstream from the project area, and other Federal dams on the Lower Columbia River are also runof-the-river dams (BPA et al. 1995a). Upstream Federal storage dams operated for flood control are Grand Coulee on the Upper Columbia, Albeni Falls on the Pend Oreille River, Libby on the Kootenai River and Hungry Horse on the Flathead River. Coordinated flow release schedules for the Federal Columbia River Power System are established each year in Watershed Management Plans. Grand Coulee Dam has the capacity to store 5.19 million acre-feet of water in Lake Roosevelt. As the largest source of water to the Mid-Columbia River, releases from Lake Roosevelt at Grand Coulee Dam have a substantial impact on Mid-Columbia River flows directly downstream.

3.3.2 WATER QUALITY

The Mid-Columbia River has been designated a "Class A," or excellent quality water body (Chapter 173-201A WAC). Reaches of the four major Mid-Columbia River tributaries studied were classified by Ecology as either Class A or Class AA (extraordinary) waters. Class AA designations apply to the Wenatchee River from the Wenatchee National Forest boundary to its

headwaters, the Little Wenatchee, White, Chiwawa, and Entiat Rivers from the Wenatchee National Forest to its headwaters, the Methow River upstream from its confluence with the Chewuch and Twisp Rivers. Characteristic protected uses of Class A and Class AA waters include water supply (domestic, industrial, and agricultural); stock watering; fish and shellfish rearing, migration, spawning, and harvesting; wildlife habitat; recreation; and commerce and navigation.

Salmon and steelhead rearing, migration, and spawning in the Mid-Columbia River and its tributaries are the beneficial water uses most sensitive to water quality. High water temperatures may delay the return of adult salmonids to spawning grounds and cause mortality of juvenile fish rearing in small tributary streams. High water temperatures and low flows may also cause stress or mortality of rearing salmonids due to reduced dissolved oxygen levels in tributaries. Mid-Columbia River salmon and steelhead are also sensitive to high levels of dissolved gas that can lead to gas bubble diseases during high spill periods.

Water quality standards for Class A waters (Chapter 173-201A WAC) include limits for fecal coliform organisms (geometric mean less than 100 colonies per 100 milliliters), dissolved oxygen (minimum requirement of 8.0 milligrams per liter), and total dissolved gas (total dissolved gas, maximum of 110 percent saturation). Temperature (maximum of 64.4° F (18.0° C) due to human activities), pH (acceptable range of 6.5 to 8.5), and turbidity (no increase of 5 nephelometric turbidity units [NTUs] if background is less than 50 NTU, or less than a 10 percent change if background is greater than 50 NTU) are additional water quality standards that apply to the project area waters.

There are also established limits to concentrations of toxic, radioactive, or deleterious material below levels that have the potential to adversely affect water use, biota, or public health. Further, aesthetic values should not be impaired, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

Class AA water quality standards (Chapter 173-201A WAC) are more stringent for some specific parameters compared to Class A standards. Fecal coliform shall not exceed a geometric mean value of 50 colonies per 100 milliliters, dissolved oxygen shall exceed the 9.5 milligrams per liter minimum, and water temperature shall not exceed 61° F (16° C) due to human activities.

To comply with Section 303(d) of the Clean Water Act, Ecology has compared existing water quality data to State standards (Ecology 1998a). As a result, several Mid-Columbia River reaches and tributaries were placed on a list of water quality limited water bodies (i.e., the 303[d] list) in 1996. The latest 303(d) list for the State of Washington was updated by Ecology in 1998 and submitted to USEPA for approval. Ecology is developing total maximum daily loads (TMDLs) for the specific water quality parameters that exceed standards. TMDL studies will include discharge limits for pollutant sources aimed at compliance with water quality standards and beneficial use restoration and protection. In addition, the PUDs are working directly with USEPA in developing the draft TMDLs for the Columbia and Snake Rivers.

Total dissolved gas supersaturation is a prominent water quality concern in the Mid-Columbia River. Total dissolved gas supersaturation in the Mid-Columbia and Snake Rivers was identified in the late 1960s and 1970s as detrimental to salmon, and those concerns have reappeared as reservoir management agencies have reinstituted spill as a means to aid fish passage at hydropower facilities (NMFS 1995). Total dissolved gas supersaturation is a condition that occurs when atmospheric gases are forced into solution at pressures that exceed the pressure of the overlying atmosphere. Water containing more than 100 percent total dissolved gas is in a supersaturated condition.

Supersaturation may occur through natural or dam-related processes that either increase the amount of air dissolved in water or reduce the amount of air the water will hold.

Total dissolved gas supersaturation in the Mid-Columbia River is well documented and has been linked to salmon and steelhead mortality and migration delays (Beiningen and Ebel 1970; Ebel et al. 1975; Gray and Haynes 1977; BPA et al. 1995a). Fish that are exposed to excessive total dissolved gas supersaturation can develop gas bubble disease, a harmful and often fatal condition.

Total dissolved gas supersaturation varies substantially by season and by dam (BPA et al. 1995a). Total dissolved gas supersaturation in the Mid-Columbia River during periods of high runoff and spill at hydropower facilities occurs primarily because of entrainment of gases when turbulent water plunges deeply in the tailrace pools. Passing water through turbines does not increase gas saturation appreciably (BPA et al. 1995a). Most total dissolved gas variation just downstream of spillways is explained by the variation in spill rates and spillway plunge depth, spill pattern and gas abatement structures and operations.

In addition to depth and pressure, total dissolved gas supersaturation is affected by water temperature. As water temperature increases, the amount of dissolved gas that can be held in solution decreases, resulting in higher total dissolved gas levels when dissolved gas concentrations remain constant. This temperature effect is important in the Mid-Columbia River where temperatures vary daily and seasonally during salmon and steelhead migrations, and where temperature regimes have been altered by hydropower projects (Beiningen and Ebel 1970). During the spring and summer, water temperatures in the Mid-Columbia River increase from about 43° F (6° C) to about 64° F (18° C). Within this temperature range, an increase in temperature of 1.8° F (1°C) will result in an

increase of about 2 percent of total dissolved gas saturation (Colt 1984).

A risk analysis conducted for the Federal Columbia River Power System biological opinion (NMFS 2000a) estimated a 4 to 6 percent increase in juvenile fish passage survival through the system, at spill levels that would not exceed 120 percent of total dissolved gas saturation in the tailrace of Columbia River dams (as compared to the 110 percent total dissolve gas water quality standard). NMFS determined that there was little evidence that this improved survival would be substantially reduced by gas bubble traumarelated mortality. Backman and Evans (2002) and Backman et al. (2002) examined migrating adult and juvenile salmon and steelhead collected from the Snake and Lower Columbia Rivers and from the bypass systems at Federal dams and reached similar conclusions. Based on the overall benefits of spilling water to pass juvenile fish in the Columbia and Snake Rivers, Ecology grants "approval to spill", thereby allowing slight exceedances of the total dissolved gas standard. Although the State water quality standard for total dissolved gas is set at 110 percent of saturation, the waiver stipulates that total dissolved gas should not exceed 115 percent in the forebay and 120 percent in the tailrace of Columbia and Snake river dams (Koehler and McDonald 1997).

3.3.2.1 Project Area

The Mid-Columbia River is relatively unpolluted and has few sources of wastewater or other pollution. However, based on the Army Corps of Engineers and Ecology monitoring results, the Mid-Columbia River was placed on the 303(d) list for total dissolved gas, water temperature, pH, and a water column bioassay (Ecology 1998a). Sources of water quality impacts include agriculture run-off and irrigation return flows, depletion of instream flows from diversions, and impoundment and flow regulation of hydropower projects.

The Army Corps of Engineers measures temperature and total dissolved gas regularly at each dam (U.S. Army Corps of Engineers 1998). The Columbia River below Rock Island (Station 44A070) and near Chelan, Washington (Station 47B070), has been monitored by Ecology for temperature, conductivity, dissolved oxygen, total dissolved gas, pH, fecal coliforms, suspended solids, turbidity, ammonia, phosphorous, nitrate and nitrite, and hardness (BPA et al. 1995a; Ecology 1998b). Total and dissolved metals data from sampling in 1998 just upstream of Rock Island Dam was also included (Parametrix 1999a).

In October 1999, Chelan County PUD began a program of water quality monitoring of Rocky Reach reservoir between the Wells Dam tailrace and the Rocky Reach tailrace (Parametrix 1999a). The primary purpose of the program is to provide information to support a Water Quality Certification for relicensing of the Rocky Reach Project. The program will also provide information needed to define the relationships between water quality and beneficial uses, including fisheries, recreation, water supply, and aesthetics. Nutrients, chlorophyll a, phytoplankton, zooplankton, and attached benthic algae are being sampled seasonally to provide information on trophic conditions. Other conventional water quality analyses include water temperature, pH, dissolved oxygen, turbidity, and total suspended solids.

The temperature regime of the Mid-Columbia River is largely influenced by releases from Lake Roosevelt, the primary deepwater storage facility created by Grand Coulee Dam. Lake Roosevelt becomes thermally stratified during the summer, and the temperatures of surface water released at Grand Coulee Dam can be very warm (U.S. Army Corps of Engineers 1993). Conversely, water released at depth (through the turbines) is cold.

High water temperatures can adversely affect salmonids by increasing the incidence of disease;

altering the timing of adult and juvenile migrations; changing incubation, hatching, and maturation times; and affecting gas supersaturation (BPA et al. 1995a; Chapman et al. 1994a, 1995a; Dauble and Mueller 1993). High water temperatures can also be lethal to fish.

Water temperatures exceeding 66° to 70° F (19° to 21° C) have also been shown to delay adult anadromous salmonid migration (Dauble and Mueller 1993). Spawning fish have limited energy reserves, and any delay in migration may reduce those reserves to the point where fish may not be able to spawn successfully (BPA et al. 1995a). High temperatures not only reduce energy reserves by blocking fish migration but also by increasing the fishes' metabolic rates.

High water temperatures can be lethal to salmon and steelhead after some exposure duration. When exposed to temperatures of 70° F (21° C) or above for more than 7 days, 50 percent of adult salmon and steelhead populations experience mortality (Dauble and Mueller 1993).

Water temperatures at levels that may not directly kill anadromous salmonids may cause indirect stress-related mortality (Dauble and Mueller 1993). Higher temperatures in combination with other stresses, such as disease through pathogenic agents and total dissolved gas, can result in increased pre-spawning mortality (a lethal effect) as well as decreased spawning viability and egg viability (McCullough 1999).

The Mid-Columbia River hydroelectric projects are run-of-the-river facilities with very limited capacity for storage and flow regulation. The very rapid flushing rates in these reservoirs limit the potential warming that can occur. Water temperatures do not appear to be significantly warmed through the Mid-Columbia River projects (U.S. Army Corps of Engineers 1993).

Jaske (1967) concluded that dams and reservoirs on the Columbia River had only a nominal effect on the annual mean temperature of the entire system, and this effect was less than 1.8° F (1° C) over the 30-year period 1936 to 1966. He also found that the projects had delayed the occurrence of annual maximum peak temperatures in proportion to the increased travel time of water flowing through the system.

Suspended solids and turbidity in the Mid-Columbia River are relatively low (BPA et al. 1995a). The Grand Coulee project and downstream reservoirs slow the river flow and allow solids to settle. Turbidity and suspended solids in Mid-Columbia River tributaries are commonly higher compared to the mainstem (BPA et al. 1995a).

Wells Dam

Water temperature and total dissolved gas levels sometimes exceed State standards at Wells Dam based on measurements reported by the U.S. Army Corps of Engineers (1998 and 1999) (Table 3-8). Ecology cited high total dissolved gas below Wells Dam and temperature exceedances in the abandoned Wells Hatchery spawning channel as the basis for listing the Columbia River as water quality limited (Ecology 1998a).

Ambient monitoring data collected by Ecology downstream from Wells Dam near Chelan, Washington generally indicates good water quality (Table 3-9). Dissolved oxygen levels stayed above 8 milligrams per liter and pH remained within the standard range of 6.5 to 8.5. Fecal coliform organisms, suspended solids, phosphorous, turbidity, and nitrate levels were low (Ecology 1998b).

Rocky Reach Dam

Temperature and total dissolved gas measurements from below Rocky Reach Dam are summarized in Table 3-8. The mainstem of the Columbia below Rocky Reach Dam is in the same segment as the Rock Island Dam. This reach was listed as water quality limited due to temperature, total dissolved gas, and a water column bioassay, as described for Rock Island Dam (Ecology 1998a).

TABLE 3-8. SUMMARY OF DAILY TEMPERATURE AND TOTAL DISSOLVED GAS MONITORING RESULTS SUMMARY FOR MID-COLUMBIA RIVER DAMS

STATION		CHIEF JOSEPH DAM	WELLS DAM	ROCKY REACH DAM	ROCK ISLAND DAM
Water Years for Tempera	ture ¹	1981 to 1993	1981 to 1997	1981 to 1997	1981 to 1997
Temperature (°F)	Max	68.0	68.0	68.7	74.6
1998 Total Dissolved Gas	s² (%)				
Forebay	Avg	107.5	108.0	107.0	107.7
	Max	114.7	113.0	117.3	121.3
	Min	98.7	103.8	90.9	90.4
Tailrace	Avg	108.7	111.9	114.4	114.7
	Max	119.3	121.2	121.2	124.8
	Min	93.3	105.8	105.8	103.2

Values are from Army Corps of Engineers 1998 (1994-1997 data for Chief Joseph Dam were not available at this site). Values are from Army Corps of Engineers 1999.

The maximum water temperature recorded in the Rocky Reach reservoir (Columbia River near Chelan) between 1981 and 1997 was 20.2°C. This was similar to the maximum temperature observed (68.6° F or 20.4°C) during the extreme drought year of 2001 (Parametrix, Inc. and Thomas Payne Associates 2002). This evaluation also observed that the presence of the Rocky Reach Project (compared to a simulated no project condition) results in some warming of the river during July and early August and some cooling from late August through October. The maximum warming effects (0.9° F) coincided with low river flows, high air temperatures, and long daylight hours. The maximum cooling effect (0.7° F), coincided with low flows, low air temperatures and shortened daylight hours. Similar temperature effects are expected for the other Mid-Columbia River projects.

Except for the total dissolved gas and water temperature issues, water quality in the Columbia River at Rocky Reach Dam is generally good (see Table 3-9). Dissolved oxygen levels do not typically decline below 8.0 milligrams per liter, and turbidity and suspended sediments are

relatively low since the dam slows the river and allows sediment to settle out. Ammonia levels are typically below the freshwater standard. Mean annual phosphate concentrations often exceed levels that could stimulate excessive algae growth, but relatively rapid flushing in the Rocky Reach reservoir limits primary productivity there (NMFS et al. 1998c).

Preliminary results from recent Chelan County PUD studies indicate that phosphorus concentrations in the water column are well below the levels that promote phytoplankton blooms, but nutrients in nearshore, shallow areas are supporting relatively high levels of attached benthic algae (Parametrix 2000b).

Excessive sediment loading to the Columbia River has occurred at the mouth of the Entiat River since much of the Entiat River watershed burned in the 1994 Tyee fire. This loading has created a delta at the mouth of the Entiat River because of increased flows from the Entiat River and decreased flows of the Columbia behind Rocky Reach Dam (Whitehall 1999 personal communication).

TABLE 3-9. WATER QUALITY DATA SUMMARY FOR THE MID-COLUMBIA RIVER

PARAMETERS	STAT	COLUMBIA RIVER NEAR ROCK ISLAND ¹	COLUMBIA RIVER AT ROCK ISLAND ²	COLUMBIA RIVER NEAR CHELAN ³	WA STATE STANDARDS ⁴
Water Years		Aug - Oct 1998	1975 to 1990	1993	
Temperature	Avg	65.8	N/A	50.0	64.4° F
(°F)	Max	69.1	73.4	64.8	•
(· /	Min	60.1	33.4	34.7	
Conductivity	Avg	134	N/A	123	
(mmhos/25°C)	Max	157	220	137	
	Min	119	95	111	
Dissolved Oxygen	Avg	8.96	N/A	11.1	>8 mg/L
(mg/L)	Max	9.53	16.3	13.5	
	Min	8.63	7.9	9.2	
Oxygen Saturation	Avg	N/A	N/A	98.6	110.0%
(%)	Max	N/A	N/A	109.2	
	Min	N/A	N/A	89.5	
рН	Avg	7.82	N/A	8.1	6.5 - 8.5
	Max	8.04	9.2	8.4	
	Min	7.62	6.8	7.6	
Fecal Coliforms	Avg	N/A	N/A	1	<100 col/100mL
(colonies/100ml)	Max	N/A	N/A	2	
	Min	N/A	N/A	1	
Suspended Solids	Avg	2 u	N/A	2	
(mg/L)	Max	2	300	3	
	Min	2 u	0.1	1	
Water Years		Aug - Oct 1998	1975 to 1990	1993	
Ammonia Nitrogen	Avg	N/A	N/A	0.010	~0.25 mg N/L
(mg N/L)	Max	N/A	0.26	0.018	-
	Min	N/A	0	0.010 u	
Total Phosphorus	Avg	N/A	N/A	0.012	~0.035 mg/L ⁵
(mg/L)	Max	N/A	0.74	0.020	
Turbidity	Avg	N/A	N/A	0.7	
(NTU)	Max	N/A	11	1.4	
(1410)	Min	N/A	0.6	0.4	
Nitrate + Nitrite	Avg	N/A	N/A	0.1	~10 mg/L
(mg/L)	Max	N/A	0.43	0.3	J
	Min	N/A	0	0.1	
Hardness	Avg	66	N/A	N/A	
(mg/L CaCO3)	Max	73	110	N/A	
,	Min	62	49	N/A	

TABLE 3-9. WATER QUALITY DATA SUMMARY FOR THE MID-COLUMBIA RIVER (CONTINUED)

Parameters	Stat	COLUMBIA RIVER NEAR ROCK ISLAND ¹	COLUMBIA RIVER AT ROCK ISLAND ²	COLUMBIA RIVER NEAR CHELAN ³	WA STATE STANDARDS ⁴
Total Metals (µg/L)					
Aluminum	Max	34.9	N/A	N/A	87
Cadmium	Max	0.13	N/A	N/A	0.78
Copper	Max	0.88	N/A	N/A	7.9
Mercury	Max	0.00068	N/A	N/A	0.012
Lead	Max	0.141	N/A	N/A	1.7
Zinc	Max	2.18	N/A	N/A	71
Dissolved Metals (µg/L)					
Aluminum	Max	4.63	N/A	N/A	N/A
Cadmium	Max	0.06	N/A	N/A	0.72
Copper	Max	0.69	N/A	N/A	7.5
Mercury	Max	0.00084	N/A	N/A	N/A
Lead	Max	0.053	N/A	N/A	1.5
Zinc	Max	2.45	N/A	N/A	70

¹ Values are from Parametrix 1999a.

Rock Island Dam

The Army Corps of Engineers measures temperature and total dissolved gas data at Rock Island Dam (see Table 3-8). Temperatures in the Columbia sometimes exceed State standards set by Ecology (64.4° F or 18°C) with a maximum of 75° F (23.8° C) at Rock Island Dam (U.S. Army Corps of Engineers 1998). The Columbia River below Rock Island Dam was placed on the 303(d) list for temperature and total dissolved gas (Ecology 1998a).

The Columbia River upstream from Rock Island Dam near Wenatchee, Washington was placed on the State 303(d) list due to a water column bioassay (Ecology 1998a). However, outfall permit samples collected in this area for the Alcoa aluminum plant indicated that all total and dissolved metals concentrations were below Washington State standards (see Table 3-9) (Parametrix 1999a). The source of toxic effects indicated by the bioassay is unknown.

Water quality in the Columbia River at Rock Island is generally good (see Table 3-9). Dissolved oxygen levels do not typically drop below the State Class A minimum standard of 8.0 milligrams per liter. Occasional dissolved oxygen concentrations below the standard may occur when hot weather coincides with irrigation withdrawals, low flows, and irrigation return flows containing high levels of nutrients and organic matter. Turbidity and suspended solids

² Values are from BPA et al. 1995a.

³ Values are from Ecology 1998b.

Values are from Chapter 173-201A WAC.

Mid-Columbia reservoirs have a retention time of less than 15 days and do not meet the classification of lake. Therefore, this value is an indication of potential eutrophication rather than a standard.

^{~ =} Values are approximate from USEPA 1986, 1998, and Chapter 173-201A WAC.

N/A = Not available/applicable

mg/L = milligrams per liter

µg/L = micrograms per liter

 $CaCO_3$ = calcium carbonate

[°]C = degrees Celsius

mmhos/25° C = milli-mhos

u = Not detected above the reported sample quantitation limit.

are usually low. The pH levels have exceeded the standard with a maximum of 9.2 at Rock Island, but yearly averages range from 6.7 to 8.1, within the standard 6.5 to 8.5 range (BPA et al. 1995a). Total phosphate concentrations at the dam (maximum of 0.74 milligrams per liter, BPA et al. 1995a) indicate enriched nutrient conditions that could promote excessive production of algae and other aquatic plants.

3.3.2.2 Associated Tributaries

The main tributaries flowing into the Mid-Columbia River are on the west side of the Columbia River: the Wenatchee, Entiat, Methow, and Okanogan Rivers. Land use on the east side is mostly non-irrigated agriculture, barren, or rangeland (USGS 1998). There are smaller streams entering from the east, such as Foster Creek and Rock Island Creek. No water quality data were available for these creeks. However, these small creeks have very limited flows, and therefore their contribution to the Columbia is considered negligible.

Wenatchee River

Water quality data were acquired at the Ecology ambient monitoring station near the mouth of the Wenatchee River and are summarized in Table 3-10. Water quality in the Wenatchee River is generally good; however, the river was placed on the 303(d) list for temperature, pH, and dissolved oxygen (Ecology 1998a). Sediment samples collected near the mouth of the Wenatchee River indicated that there were no toxic accumulations of organic or inorganic chemicals present (Hindes 1994).

Various tributaries of the Wenatchee River are on the 303(d) list, indicating impaired water quality conditions that limit beneficial uses of these streams (Ecology 1998a). Mission Creek, the tributary closest to the mouth of the Wenatchee River, is listed for temperature, fecal coliforms, DDT, and guthion (azinphos-methyl). Mission Creek was also listed for concentrations of 4,4'-DDT and 4,4'-DDE above standard levels in edible rainbow trout tissue. Low dissolved oxygen conditions have also been measured in Mission Creek (Hindes 1994). Additional information specific to Mission Creek is included in the draft Wenatchee River watershed Ranking Report Addendum (Wenatchee River Watershed Steering Committee/Technical Advisory Committee 1996).

Peshastin Creek, upstream of Mission, is 303(d) listed for temperature (Ecology 1998a). Substandard dissolved oxygen concentrations, and elevated turbidity and fecal coliform concentrations have also been measured in Peshastin Creek (Hindes 1994). Icicle Creek enters the Wenatchee River upstream of Peshastin Creek and is listed for dissolved oxygen and temperature. Upstream of Icicle Creek is Chiwaukum Creek, which is listed for temperature. Nason Creek enters where Wenatchee Lake drains into the Wenatchee River, and is listed for temperature. The Little Wenatchee River drains into Wenatchee Lake, and is also listed for temperature. Low dissolved oxygen conditions have also been measured on the Little Wenatchee River (Hindes 1994).

The Chiwawa and White Rivers, the largest tributaries that drain the north end of the Wenatchee River watershed, were not included on the 303(d) list (Ecology 1998a). However, low dissolved oxygen concentrations have been measured on several occasions in both streams (Hindes 1994). Other creeks in the Wenatchee River watershed are Brender Creek, a tributary of Mission Creek listed for fecal coliforms and dissolved oxygen; and Chumstick Creek, listed for dissolved oxygen, pH, and fecal coliforms (Ecology 1998a).

WATER QUALITY DATA SUMMARY FOR MID-COLUMBIA RIVER TRIBUTARIES **TABLE 3-10.**

STATION		WENATCHEE RIVER AT WENATCHEE	ENTIAT RIVER NEAR ENTIAT	METHOW RIVER NEAR PATEROS	OKANOGAN RIVER AT MALOTT	WA STATE STANDARDS ¹
Water Years		1992 to 1997	1994 to 1997	1992 to 1997	1992 to 1997	
Temperature	Avg	48.4	45.5	46.9	50.2	64.4° F
(° F)	Max	70.2	66.9	66.2	72.1	
	Min	32.0	32.0	32.0	32.0	
Conductivity	Avg	62	84	145	221	N/A
(mmhos/25°C)	Max	107	152	300	396	
	Min	28	32	59	86	
Dissolved Oxygen	Avg	12.3	12.2	11.8	10.8	>8 mg/L
(mg/L)	Max	15.6	15.4	15.1	14.7	
	Min	9.4	9.1	9.2	7.7	
Oxygen Saturation	Avg	106.4	102.2	101.5	95.1	110.0%
(%)	Max	127.3	115.0	109.0	109.6	
	Min	84.6	96.1	96.5	85.0	
рН	Avg	7.7	8.0	8.0	8.1	6.5 - 8.5
	Max	9.4	9.0	8.7	8.5	
	Min	6.8	7.4	7.0	7.4	
Fecal Coliforms	Avg	16	11	8	25	<100 col/100mL
(colonies/100ml)	Max	130	72	150	96	
	Min	0.05	1 u	1 u	1	
Suspended Solids	Avg	11	13	7	21	N/A
(mg/L)	Max	116	198	122	153	
	Min	1	1 u	1 u	1 u	
Ammonia Nitrogen	Avg	0.009	0.008	0.008	0.009	~0.25 mg/L
(mg/L)	Max	0.018	0.022	0.019	0.023	
	Min	0.010 u	0.010 u	0.010 u	0.010 u	
Total Phosphorus	Avg	0.027	0.045	0.027	0.044	N/A
(mg/L)	Max	0.785	0.911	0.817	0.867	
	Min	0.010 u	0.010 u	0.010 u	0.010 u	
Turbidity	Avg	3.6	3.9	2.5	7.2	N/A
NTUs	Max	60.0	50.0	45.0	65.0	
	Min	0.3	0.4	0.3	0.8	
Nitrate + Nitrite	Avg	0.2	0.2	0.2	0.1	~10 mg/L
(mg/L)	Max	0.4	0.4	0.4	0.1	
	Min	0.1	0.1	0.1	0.1	

N/A = Data not available.

Source: Ecology 1998b.

 $^{^{1}}$ Values are from Chapter 173-201A WAC. $_{\sim}$ = Values are approximate from USEPA 1986, 1998, and Chapter 173-201A WAC.

u = Not detected above reported sample quantitation limit.

Other parameters in the Wenatchee River have levels below State standards. Although fecal coliform levels included a maximum of 130 colonies per 100 milliliters (Ecology 1998b), the geometric mean met water quality standards. Turbidity, suspended solids, nitrate, and ammonia are usually low (Ecology 1998b). Total phosphorous levels are high at certain times (maximum of 0.79 milligrams per liter), and may stimulate algae growth (Ecology 1998b).

Based largely on water quality conditions, the Chelan County Conservation District led a diverse group of organizations, agencies, and individuals in a consensus ranking of subwatersheds within the Wenatchee River watershed (Hindes 1994). Mission Creek was assigned the number one ranking based on exceedances of water quality standards, concerns that elevated nutrients and bacteria may be causing water quality problems in the Lower Wenatchee River, sandstone soils that are vulnerable to erosion following disturbance, the presence of viable anadromous fish runs, and other criteria.

Local landowners and residents have formed a watershed association and are working with the Chelan County Conservation District on a Federal grant and other cleanup projects to improve water quality in the Mission Creek subwatershed (Wenatchee River Watershed Steering Committee 1998). Other subwatersheds were ranked in the following order: Chumstick Creek, White River, mainstem Wenatchee River, Nason Creek, Peshastin Creek, Icicle Creek, the Chiwawa River, and the Little Wenatchee River. A watershed action plan and implementation schedule have been developed to promote water quality improvements throughout the Wenatchee River watershed from on-site sewage systems, agriculture, forestry, and stormwater (Wenatchee River Watershed Steering Committee 1998).

Entiat River

Entiat River water quality is generally good (see Table 3-10). The Entiat River was listed on the State 303(d) list in 1996 because temperature and pH levels that exceeded State standards for monitoring during 1985 through 1991. However, based on acceptable water temperatures and pH in more recent years, Ecology has removed the Entiat River from its most recent proposed list (Ecology 1998a). No tributaries of the Entiat River were listed as water quality limited.

Dissolved oxygen levels measured near the town of Entiat have a range of 9.1 to 15.4 milligrams per liter (Ecology 1998b), meeting the Washington State minimum standard of 8.0 milligrams per liter. Fecal coliform, suspended solids, ammonia, turbidity, and nitrate levels are usually low. Total phosphorous can be high at times and may stimulate algal growth (Ecology 1998b).

Several large fires have occurred in the Entiat River Basin since 1970, the most recent one in 1994. This has resulted in increased sediment loads in the Entiat River, with large deposits forming a delta at the Entiat River mouth and into the Columbia River. Immediately following the fire, the USFS implemented erosion and flood control measures. Monitoring now includes sediments and temperature. It is evident that more sediment is being transported, but water temperatures have not changed much since the fire of 1994 (Whitehall 1999 personal communication).

Methow River

Water quality data from Ecology's monitoring station near Pateros on the Methow River are summarized in Table 3-10. Water quality is generally good. The Methow River is listed for temperature upstream of the mouth at the inflow to the Winthrop National Fish Hatchery (Ecology 1998a). The Twisp River, a tributary of the Methow River, is also listed for temperature.

The Upper Methow and Chewuch Rivers are classified as AA (extraordinary), and the Lower Methow and Twisp Rivers meet the class A (excellent) standards. Discharges from Winthrop and Twisp municipal wastewater treatment systems have not been identified as factors affecting the water quality. Sediment loading is not considered a major problem even with the logging, grazing, land clearing, agricultural cropland, development, and road building in the watershed (NMFS et al. 1998c).

Dissolved oxygen levels in the Methow River usually remain above the State minimum standard of 8 milligrams per liter, pH generally remains within the limits of 6.5 to 8.5, and fecal coliform counts are generally low. Suspended solids, ammonia, turbidity, and nitrate generally have low levels, while phosphorous concentrations may stimulate algal growth (Ecology 1998b).

Okanogan River

Water quality data collected by Ecology at the Malott sampling station on the Okanogan River is summarized in Table 3-10. The Okanogan River is listed for dissolved oxygen, temperature, and fecal coliform organisms (Ecology 1998a). Water temperatures exceed standards partly because of natural phenomena (low gradient and solar radiation on the upstream lakes), as well as sedimentation and summer low flows due to Canadian water storage and irrigation (NMFS et al. 1998c). The Okanogan was also listed for 4,4'-DDE, 4,4'-DDD, PCB-1254, and PCB-1260 concentrations above standards in edible carp tissue during 1994 (Ecology 1998a). A study in 1977 by the Pacific Northwest River Basins Commission identified that water quality problems have been attributed to return flows of irrigation water, livestock impacts on bank vegetation and stability, erosion from nonirrigated cropland, and forest harvest practices, such as road construction (NMFS et al. 1998c).

Several tributaries of the Okanogan River have also been listed as water quality limited (Ecology

1998a). Tallant Creek and an unnamed creek at Okanogan river mile 28.4 were listed for DDT. The Similkameen River, a major tributary of the Okanogan near the Canadian border, is listed for temperature at the Ecology monitoring station (river mile 5.0) and at the inflow to the Similkameen Hatchery. Also listed is arsenic, likely due to tailings piles in British Columbia (Ecology 1998a). Osoyoos Lake, on the Canadian border, is listed for 4,4'-DDE and 4,4'-DDD concentrations above standards in an edible fish tissue sample collected in 1989. Ninemile Creek runs into Osoyoos Lake, and is listed for DDT (Ecology 1998a). Dissolved oxvgen. temperature, and pH levels have exceeded State standards in Omak Creek, but this stream is not 303(d)-listed because it is on the Colville Indian Reservation and does not fall under the jurisdiction of the State (Ecology 1998a).

The Okanogan River at Malott has pH levels within the State standard range of 6.5 to 8.5, and ammonia and nitrate levels are low (Ecology 1998b). Suspended solids and turbidity seem to be elevated at the mouth of the river compared to what would be expected from the Similkameen River and Osoyoos Lake combined (NMFS et al. 1998c). Phosphorous concentrations can increase at times and may stimulate algal growth (Ecology 1998b).

3.3.2.3 Columbia River System

General descriptions of water quality data for the Columbia River indicate that dissolved oxygen, turbidity, suspended sediments, and pH levels are not a problem. Ammonia levels have exceeded criteria upstream of this reach at Grand Coulee Dam and downstream of this reach at Priest Rapids Dam (BPA et al. 1995a). Rock Island Dam ammonia levels were below criteria (BPA et al. 1995a), as were levels near Chelan (Ecology 1998b). In general, annual mean nitrate levels remain below criteria.

Phosphorus concentrations in Lake Roosevelt and the Mid-Columbia River have greatly declined since the 1980s (Rensel Associates 1999). This change has been attributed to the 1995 termination of phosphorus discharges to the Columbia River from a Canadian fertilizer plant just north of the border. The nutrient decline has resulted in a shift from borderline nitrogen limitation of phytoplankton growth and mesotrophic (i.e., moderately enriched) conditions to strong phosphorus limitation and oligotrophy (i.e., nutrient poor, low productivity conditions) in Lake Roosevelt and the Mid-Columbia River. Further decline of nutrient

levels in the mainstem river may result as large upstream reservoirs retain available nutrients.

There are a few apple-packing facilities located along the Mid-Columbia River. Most of these facilities only discharge non-contact cooling water. There are about 10 facilities discharging process water, which includes chlorine, and they are monitored according to Ecology permits. These facilities generally meet permit limits and are not considered to have a major impact on the water quality (Huber 1999 personal communication).

3.4 VEGETATION

Key Terms

Aquatic Macrophytes – Plants that occur entirely immersed within or under water.

Noxious Weeds – Non-native plants that have been introduced to Washington and can be destructive and competitive with native plants and difficult to control by cultural or chemical practices. These exotic species can reduce crop yields, replace native plant and animal habitat, affect land values and recreational opportunities, and infiltrate waterways.

Riparian Vegetation – Riparian zones are broadly defined as those non-aquatic areas contiguous with waterbodies (wetlands, lakes, streams, and rivers) that are influenced by, and which influence, that waterbody. Often riparian zones exhibit higher plant and animal diversity and productivity than surrounding uplands, and are particularly important to fish and wildlife in arid regions. Riparian vegetation may or may not be distinct from the adjacent upland vegetation.

Wetlands – Areas that are inundated by surface or groundwater frequently enough to support vegetation that requires saturated or seasonally saturated soil conditions for growth and reroduction. Wetlands generally include marshes, bogs, peatlands, and similar areas such as river overflows, mudflats, and natural ponds.

* See Chapter 7 for a complete listing of all Key Terms.

Vegetation influences the quality of salmonid feeding, resting, rearing, and migratory habitat through several mechanisms including water quantity, quality, and temperature, as well as foraging opportunities. Evapotranspiration and infiltration in a watershed, which directly affect the amount of water released to streams, is dependent on the type and extent of vegetation present. Vegetation can control the nature and quality of sediment entering streams by its ability to bind soils and sediments. Shoreline and riparian vegetation provide shading to streams, which directly influences stream temperatures and the resulting survival of many fish species.

Litter fall, photosynthesis, and respiration also provide food sources for fish as described below under riparian vegetation (Spence et al. 1996).

Land use agricultural and industrial practices (such as forestry, grazing, and mining) can alter watershed processes by changing the amount and type of upland vegetation. These changes affect the quantity and routing of water, sediments, nutrients, and other dissolved materials delivered to streams (Spence et al. 1996). In addition, irrigation and application of chemical fertilizers and pesticides associated with these land uses can affect water quality.

Described below is the vegetation within the Columbia River system, classified in groups by upland, riparian/wetland, and aquatic plant communities. These sections are followed by a discussion of rare plants and noxious weeds. The latter sections include tables of rare plant and noxious weed species that potentially occur in the project area or associated tributaries.

3.4.1 UPLAND VEGETATION

3.4.1.1 Project Area

The botanical investigations that have been conducted directly in the project area of the dams (Caplow 1990) identified undeveloped areas of shrub-steppe vegetation. These investigations have been part of more recent license requirements to determine if rare and sensitive plant species may occur in the vicinity of the project area and whether project operations can affect these species (FERC 1975a, 1989a). Vegetation sampling can also be a component of habitat surveys for determining adequacy of riparian and upland habitat for fish and wildlife resources. From these surveys, records indicate that the flora is dominated by big sagebrush, rabbitbrush (*Chrysothamnus* spp.), bitterbrush (Purshia tridentata), bluebunch wheatgrass, balsamroot (Balsamorhiza sagitatta), and numerous non-native weed species such as cheat (Bromus tectorum), bulbous bluegrass (Poa bulbosa), knapweeds (Centaurea spp.), Russian thistle (Salsola kali), and western tansy-mustard (Descurainia pinnata).

Human occupation and land use occurs throughout the project area, ranging from residential and commercial development to irrigated orchards (predominantly apple, pears, and cherries) and rangeland grazing. These land use practices typically result in the change from native plant communities to communities dominated by non-native plants. Human occupation or use has occurred on more than 75 percent of the project area.

3.4.1.2 Associated Tributaries

Because of their large watershed basins, the associated tributaries pass through a variety of vegetation zones, including, at lower elevations, the big sagebrush/bluebunch wheatgrass or shrubsteppe zone. Above this zone are: (1) the Artemisia tripartita/Festuca idahoensis (three-tip sagebrush/Idaho fescue zone) shrub-steppe zones; (2) forested low-montane zones dominated by ponderosa pine, Douglas-fir, and grand fir (Abies grandis); and (3) subalpine zones dominated by lodgepole pine (Pinus contorta), Engelmann spruce (Picea engelmannii), and subalpine fir (Abies lasiocarpa) (Franklin and Dyrness 1988). Alpine areas that are generally devoid of trees occur at the highest elevations in the watersheds of the associated tributaries.

3.4.1.3 Mid-Columbia River System

The Columbia River floodplain and the foothills of the Cascade Mountains are primarily within the Artemisia tridentata/Agropyron spicatum (big sagebrush/bluebunch wheatgrass or shrub-steppe) vegetation zone, which is characteristic of the driest portions of the Columbia Basin physiographic province (Daubenmire 1988; Franklin and Dyrness 1988). The Columbia River passes through four major plant communities within this vegetation zone, beginning near Richland, Washington, and proceeding north through the Mid-Columbia River projects: shrub-steppe (with sagebrush), shrub-steppe (without sagebrush), ponderosa pine (Pinus ponderosa), and stands of Douglas-fir (Pseudotsuga menziesii) and grand fir (Abies grandis).

3.4.2 RIPARIAN AND WETLAND VEGETATION

Riparian vegetation directly affects aquatic biota by contributing organic detritus (dead leaves and other plant material, and insects) to the associated water body. These organic inputs form the basis of the aquatic food web, which includes salmonid species. Most aquatic organisms (including invertebrates and fish) are indirectly dependent on inputs of terrestrial detritus to the stream for their food.

Riparian vegetation also moderates temperature gradients in narrow reaches of streams and rivers where forest and shrub vegetation can shade the water. Riparian vegetation can slow stream velocities, remove sediment, and transform chemical pollutants, while naturally armoring shorelines and contributing large woody debris. Without riparian vegetation, a stream's biological substrate can diminish. Riparian vegetation also provides non-aquatic wildlife habitat and effective buffers between water resources and neighboring agricultural and urban development.

Changes in riparian vegetation and the biotic processing of detritus, as well as other factors, determine the kinds and abundance of aquatic organisms living in streams, from headwaters to large rivers. Removal of riparian vegetation significantly affects stream organisms by: (1) decreasing food inputs; (2) increasing the potential for primary productivity in aquatic plants; (3) increasing summer water temperatures; (4) changing water quality and quantity; and (5) decreasing terrestrial habitat for adult insects (Knight and Bottorff 1984).

Wetlands provide physical and biological functions in a watershed. Biological functions include food web support and habitat for fish and wildlife. Physical functions include stream baseflow support, flood storage and floodflow desynchronization, and nutrient and sediment retention.

Maps of important wetland and riparian habitats for wildlife have been developed by WDFW. Wetlands identified by the National Wetland Inventory are also included on these maps. Additional habitat inventory work has been conducted by Payne et al. (1975) and by the Washington Natural Heritage Program.

3.4.2.1 Project Area

Historically, riparian vegetation formed in dynamic equilibrium with the disturbance caused by seasonal flows and flood events of the Columbia River. This dynamic, successional regime characterizing the natural system changed when hydroelectric dams were placed in the Columbia River, where relatively stable pool elevations favor mature plant communities. Currently, riparian zones in the Columbia River system vary from sparse vegetation to relatively complex, mature shrub- and tree-dominated habitats. Many areas along the reservoirs have been converted to orchards or other agricultural or development uses. Portions of shoreline have also been rip-rapped to prevent erosion.

Development of riparian vegetation in the project area is restricted by the arid conditions, rip-rapped embankments, and agricultural development. At lower elevations in undeveloped areas of the tributaries, shrub and forest riparian zones are dominated by species such as white alder (*Alnus rhombifolia*), water birch (*Betula occidentalis*), black cottonwood (*Populus trichocarpa*), willows (*Salix* spp.), and quaking aspen (*Populus tremuloides*). Common shrub species include wood rose (*Rosa woodsii*), redtwig dogwood (*Cornus sericea*), and snowberry (*Symphoricarpos alba*). Common herbaceous species include stinging nettle (*Urtica dioica*) and reed canarygrass (*Phalaris arundinacea*).

Wetland habitat in the vicinity of the Rock Island Dam includes mostly emergent habitats dominated by cattail (*Typha latifolia*) and bulrush (*Scirpus* spp.) (FERC 1988). Small areas of shrub-dominated wetlands are predominately willows and Russian-olive (*Elaeagnus angustifolius*). Wetland habitat in the vicinity of the Rocky Reach Dam consists of small patches of emergent vegetation located in protected coves where sediment has accumulated. Palustrine emergent habitat accounted for 13.1 acres of wetland habitat, where 90 patches of such habitat

averaged 0.2 acre (FERC 1996b). These areas are dominated by cattail and bulrush.

3.4.2.2 Associated Tributaries

Along associated tributaries, riparian zones vary from being barren of vegetation to supporting relatively complex shrub- and tree-dominated habitats. Many areas along associated tributaries have been converted to orchards or other agricultural or development uses. Portions of shoreline have also been rip-rapped to prevent erosion.

Because of their large basins, associated tributaries pass through a variety of naturally occurring vegetation zones. From lower to higher elevations, these zones include the *Artemisia tripartita/Festuca idahoensis* (three-tip sagebrush/Idaho fescue zone) shrub-steppe; forested low-montane zones dominated by ponderosa pine, Douglas-fir, and grand fir (*Abies grandis*); and subalpine zones dominated by lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmannii*), and subalpine fir (*Abies lasiocarpa*) (Franklin and Dyrness 1988).

The character of their associated upland and riparian zones changes substantially as these tributaries pass from one zone to another. Along the deeply incised streams of the Cascade Mountains and Okanogan Highlands, riparian vegetation is usually limited to stream banks, but is more extensive where level bottomlands or terraces exist.

Large areas of wetlands exist within the watersheds of the associated tributaries. For example, more than 4,300 acres of wetlands have been mapped on the National Wetland Inventory in the Entiat watershed (Entiat Planning Unit 1999) and more than 17,200 acres in the Wenatchee watershed (Wenatchee River Watershed Steering Committee 1996). Most of these are associated with the upper and midportions of the rivers. Vegetated wetland habitats

include emergent, shrub, and forested wetland classes.

3.4.2.3 Mid-Columbia River System

Because most of the Mid-Columbia River system is impounded, wetland and riparian habitats are similar to those described for the project area (see Section 3.4.2.1, Project Area).

3.4.3 AQUATIC VEGETATION

Aquatic plant communities in river and reservoir systems are characterized as more or less distinct zones of vegetation that are influenced by a complex of environmental variables such as water depth, exposure, turbidity, salinity, and soil characteristics (Swindale and Curtis 1957; Sculthorpe 1967; Cowardin et al. 1979). Aquatic bed habitats are those wetland and deepwater zones dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years (Cowardin et al. 1979). Aquatic bed habitats include areas dominated by algae or aquatic mosses, as well as rooted or vascular plants. Such habitat provides escapement and rearing habitat for numerous aquatic species. The scope of the following discussion is limited to aquatic bed habitats dominated by vascular plants (aquatic macrophytes).

3.4.3.1 Project Area

Some information is available on aquatic vegetation in the project area reservoirs (Tabor et al. 1980). Vegetation mapping in and around the Rocky Reach reservoir (river miles 473.6 to 515.5) identified 979 acres of aquatic bed habitat. Approximately 470 acres of this was dominated at that time by Eurasian milfoil (*Myriophyllum spicatum*), a State-listed noxious weed (Ebasco Environmental 1990). Other species included waterweed and pondweeds (*Potamogeton* spp.). Between 1984 and 1991, the overall acreage of aquatic biomass in the Rocky Reach reservoir

increased approximately 15 percent (FERC 1996b). Duckweed, sago pondweed, and waterweed have also been documented in aquatic bed communities at Wells reservoir (river mile 537.2) (Tabor et al. 1980).

3.4.3.2 Associated Tributaries

Little information is available on aquatic vegetation resources in the associated tributaries. It is likely that many of the same aquatic macrophytes found in reservoirs of the Columbia River also occur in suitable habitats in the associated tributaries.

3.4.3.3 Mid-Columbia River System

Prior to the construction of dams, aquatic bed habitats along the Columbia River system were predominantly limited to narrow zones along the shorelines and larger zones in backwater areas. Data collected by Tabor et al. (1980) from 23 sites along the Columbia River between Rooster Rock State Park (river mile 128.5) and Washburn Island (river mile 538) suggest that floating and submergent aquatic plants were reduced by predam water level fluctuations. Historically, where water level fluctuation was reduced, plants with these growth forms occurred predominantly and had higher areal coverage.

Aquatic bed vegetation in the lower non-tidal reaches of the Columbia system (Interstate 5 to The Dalles, river miles 106 and 192, respectively) is typically restricted to embayments and other protected sites. These areas are dominated by native species such as duckweed (*Lemna minor*), waterweed (*Elodea canadensis*), sago or fennel-leaved pondweed (*Potamogeton pectinatus*), and the non-native curled pondweed (*Potamogeton crispus*) (Stanford Research Institute 1971; Tabor et al. 1980; Annear 1992 personal communication). No information is available on the areal extent of aquatic bed habitat in this part of the Columbia system.

At McNary reservoir (river mile 317), sago and curled pondweeds are the dominant species in aquatic bed communities (Tabor et al. 1980). In their investigation of the Hanford Reach (river miles 345 to 396), a free-flowing reach of the Columbia River upstream of McNary Dam, Fickeisen et al. (1980) identified no aquatic bed vegetation. However, the native persistent-sepal or Columbia yellow cress (*Rorippa columbiae*) (a Federal species of concern and State-listed threatened species) grows submerged for most of the year in portions of the Hanford Reach (Sackschewsky et al. 1992) and forms small patches of aquatic bed vegetation (Antieau 1992 personal observation).

3.4.4 RARE PLANTS

The project area and associated tributary watersheds provide habitat for numerous rare plant species (Table 3-11). Although there are only two species Federally listed as threatened in the vicinity of the project area, there is also one species that is proposed for listing, and eleven plants that are Federal species of concern. All of the species in Table 3-11 are listed as sensitive, threatened, or endangered by the State of Washington (USFWS 1998; WDNR 1997). The Federally listed species (Ute ladies' tresses; Spiranthes diluvialis) occurs in Okanogan County, and has recently been found along the Rocky Reach reservoir shoreline (Chelan County PUD 2001). This hydrophilic orchid would likely be affected by substantial changes in the reservoir water surface elevation, particularly reservoir drawdown. The other Federally listed species, Oregon checker-mallow (Sidalcea oregana var. calva), occurs in the Wenatchee River watershed, but does not occur in or near the immediate project area of the dams and would not be affected by reservoir water level changes.

All of the species without Federal listing status included in Table 3-11 are known to occur in the watersheds of the associated tributaries and/or in areas close to the project areas (within 50 feet of

the maximum pool elevation of the project reservoirs). Ten species have populations within 50 feet of the maximum pool elevation of some reservoirs in the project area (Caplow 1990; Chelan County PUD 2001). However, all but three of these ten species are upland-dwelling species and are not associated with the wetted shorelines of these reservoirs. One exception, longsepal globemallow (*Illiamna longisepala*),

occurs in riparian zones associated with tributaries to the Columbia River. Other exceptions include Ute ladies' tresses and giant helleborine (*Epipactis gigantea*), known to occur on or near the wetted shorelines of some project area reservoirs. The remaining species in Table 3-11 occupy a broad diversity of habitats ranging from low elevation to high elevation and wetland/riparian habitats to rock/cliff habitats.

TABLE 3-11. PROPOSED, THREATENED, ENDANGERED, AND SENSITIVE PLANT SPECIES FOUND IN THE PROJECT AREA OR IN WATERSHEDS OF THE ASSOCIATED TRIBUTARIES

SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS ¹	STATE STATUS ²	OCCURRENCE ³
Agoseris elata	Tall agoseris	-	S	AT
Agrostis borealis	Northern bentgrass	-	S	AT
Anemone nuttalliana	Pasqueflower	-	S	AT
Aster sibericus var. meritus	Arctic aster	-	S	AT
Astragalus arrectus	Palouse milk-vetch	-	S	AT, PA
Astragalus misellus var. pauper	Pauper milk-vetch	-	S	AT, PA
Astragalus sinuatus	Whited milk-vetch	FSC	Е	AT
Botrychium ascendens	Triangular-lobed moonwort	FSC	S	AT
Botrychium crenulatum	Crenulate moonwort	FSC	S	AT
Botrychium lanceolatum	Lance-leaved grape fern	-	S	AT
Botrychium lunaria	Moonwort	-	S	AT
Botrychium paradoxum	Two-spiked moonwort	FSC	S	AT
Botrychium pinnatum	St. John moonwort	-	S	AT
Botrychium simplex	Little grape-fern	-	S	AT
Camissonia pygmaea	Dwarf evening-primrose	-	Т	AT
Carex atrosquama	Blackened sedge	-	S	AT
Carex buxbaumii	Buxbaum sedge	-	S	AT
Carex capillaris	Hair-like sedge	-	S	AT
Carex chordorrhiza	Cordroot sedge	-	S	AT
Carex comosa	Bristly sedge	-	S	AT
Carex dioica	Yellow bog sedge	-	S	AT
Carex eleocharis	Narrow-leaved sedge	-	S	AT
Carex heterone	Different-nerved sedge	-	S	AT
Carex hystricina	Porcupine sedge	-	S	AT
Carex magellanica ssp. irrigua	Poor sedge	-	S	AT
Carex norvegica	Scandanavian sedge	-	S	AT
Carex proposita	Smoky mountain sedge	-	S	AT
Carex saxatilis var. major	Russett sedge	-	S	AT

TABLE 3-11. PROPOSED, THREATENED, ENDANGERED, AND SENSITIVE PLANT SPECIES FOUND IN THE PROJECT AREA OR IN WATERSHEDS OF THE ASSOCIATED TRIBUTARIES (CONTINUED)

SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS ¹	STATE STATUS ²	OCCURRENCE ³
Carex scirpoidea var. scirpoidea	Canadian single-spike sedge	-	S	AT
Carex sychnocephala	Many-headed sedge	-	S	AT
Carex tenuiflora	Sparse-leaved sedge	-	S	AT
Carex vallicola	Valley sedge	-	S	AT
Carex xerantica	White-scaled sedge	-	S	AT
Chaenactis thompsonii	Thompson chaenactis	-	S	AT
Chrysosplenium tetrandum	Northern golden-carpet	-	S	AT
Cicuta bulbifera	Bulb-bearing water hemlock	-	S	AT
Cryptantha spiculifera	Snake River cryptantha	-	S	AT
Cryptogramma stelleri	Steller rockbrake	-	S	AT
Cypripedium fasciculatum	Clustered lady-slipper orchid	FSC	Т	AT
Cypripedium parviflorum	Yellow lady-slipper orchid	-	Е	AT
Delphinium viridescens	Wenatchee larkspur	FSC	Т	AT
Draba aurea	Golden draba	-	S	AT
Draba cana	Lance-leaved draba	-	S	AT
Eleocharis rostellata	Beaked spike-rush	-	S	
Elitrichium nanum var. elongatum	Pale alpine forget-me-not	-	S	АТ
Epipactis gigantea	Giant helleborine	-	S	AT, PA
Erigeron salishii	Salish fleabane	-	S	AT
Eriophorum viridicarinatum	Green-keeled cotton-grass	-	S	AT
Gentiana glauca	Glaucous gentian	-	S	AT
Gentianella tenella	Slender gentian	-	S	AT
Geum rivale	Water avens	-	S	AT
Geum rossii var. depressum	Ross avens	-	S	AT
Githopsis specularioides	Common blue-cup	-	S	AT, PA
Hackelia hispida var. disjuncta	Sagebrush stickseed	-	S	AT, PA
Hackelia venusta	Showy stickseed	FSC	E	AT
Iliamna longisepala	Longsepal globemallow	-	S	AT, PA
Listera borealis	Northern twayblade	-	S	AT
Mimulus pulsiferae	Pulsifer monkeyflower	-	S	AT
Nicotiana attenuata	Coyote tobacco	-	S	AT, PA
Oxytropis campestris var. gracilis	Slender crazyweed	-	S	АТ
Parnassia kotzebuei	Kotzebue grass-of-Parnassus	-	S	AT
Pellaea brachyptera	Sierra cliff-brake	-	S	AT
Pellaea breweri	Brewer cliff-brake	-	S	AT
Petrophyton cinerascens	Chelan rockmat	FSC	Т	AT, PA
Phacelia lenta	Sticky phacelia	FSC	Т	AT
Platanthera obtusta	Small northern bog orchid	-	S	AT

TABLE 3-11. PROPOSED, THREATENED, ENDANGERED, AND SENSITIVE PLANT SPECIES FOUND IN THE PROJECT AREA OR IN WATERSHEDS OF THE ASSOCIATED TRIBUTARIES (CONTINUED)

SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS ¹	STATE STATUS ²	OCCURRENCE ³
Polemonium viscosum	Skunk polemonium	-	S	AT
Potentilla diversifolia var. perdissecta	Diverse-leaved cinquefoil	-	S	AT
Potentilla nivea	Snow cinquefoil	-	S	AT
Potentilla quinquefolia	Five-leaved cinquefoil	-	S	AT
Rubus acaulis	Nagoonberry	-	S	AT
Salix glauca	Glaucous willow	-	S	AT
Salix tweedyi	Tweedy willow	-	S	AT
Salix vestita var. erecta	Rock willow	-	EX	AT
Sanicula marilandica	Black snake-root	-	S	AT
Saxifraga cernua	Nodding saxifrage	-	S	AT
Saxifraga rivularis	Pygmy saxifrage	-	S	AT
Saxifragopsis fragarioides	Strawberry-saxifrage	-	S	AT
Sidalcea oregana var. calva.	Oregon checker-mallow	PE	Е	AT
Silene seelyi	Seely silene	FSC	Т	AT
Sisyrinchium septentrionale	Blue-eyed grass	-	S	AT
Spiranthes diluvialis	Ute ladies' tresses	FT	Т	AT, PA
Spiranthes porrifolia	Western ladies' tresses	-	S	AT
Talinum sediforme	Okanogan fameflower	-	S	AT
Teucrium canadense ssp. viscidum	Woodsage	-	S	АТ
Trifolium thompsonii	Thompson clover	FSC	Т	AT, PA
Trimorpha elata	Tall bitter-fleabane	-	S	AT
Utricularia minor	Lesser bladderwort	-	S	AT
Vaccinium myrtilloides	Velvet-leaf blueberry		S	AT

¹ FSC = Federal Species of Concern, FT = Federal Threatened, PE = Proposed Endangered

Source: WDNR (1997).

3.4.5 Noxious WEEDS

The State of Washington regulates the presence and spread of noxious weeds under authority of the Noxious Weed Control Act and its implementing code (RCW 17.10.007 and WAC 16-750). These species are of relevance because habitat improvement projects planned under any alternative should include plans to ensure that these plants do not spread, and are eradicated whenever encountered.

State-listed noxious weeds are classified into one of three categories. Class A weeds are non-native species with a limited distribution in Washington. Eradication of these species is mandatory in Washington. Class B weeds are non-native species that are presently limited in distribution in Washington and pose a serious threat to resources. Control of these weeds is mandatory in those counties in which these species occur.

Class-B Designate weed species are those species where control is mandatory. Control is defined as

² S = State-listed Sensitive, T = State-listed Threatened, E = State-listed Endangered, EX =Potentially Extirpated from Washington ³ PA = Project Area (within 15 meters of maximum pool elevation), AT = Associated Tributaries

the prevention of all seed production in a single program year, with the eventual aim being a reduction of the total acreage of infestation to a point where eradication is possible. Class C weeds are noxious weeds that are common throughout most of Washington. Infestations of Class-B Non-designate and Class C weeds are typically so expansive that weed control or the prevention of seed production is not feasible. Some Class C weeds are selected by the various County Weed Boards as priority weeds in their counties, where control becomes mandatory for those selected species. Weeds designated as "Additional" by some counties are those designated by the county noxious weed control board as requiring control in that county.

New invader weeds are those species not yet formally recognized by the State Noxious Weed Board as Class A weeds, but present in a county

and posing a serious threat. For purposes of this analysis, only Class A, B-Designate, Additional, and New Invader weeds are included. Numerous species of State-listed noxious weeds are found within the vicinity of the project area and in the watersheds of associated tributaries (Table 3-12). Generally, Class B weeds are more abundant and broadly distributed than the other classified noxious weeds. Knapweeds and starthistles (Centaurea spp.), kochia (Kochia scoparia), and hawkweeds (*Hieracium* spp.) are frequently present in upland areas surrounding each of the projects, in the watersheds of the associated tributaries, and in the Mid-Columbia River system. Parrotfeather (Myriophyllum aquaticum), and Eurasian water milfoil (Myriophyllum spicatum), fanwort (Cabomba caroliniana), and purple loosestrife are found in reservoirs and associated wetland habitats of the project area and associated tributaries.

TABLE 3-12. STATE-LISTED NOXIOUS WEEDS FOUND IN CHELAN, DOUGLAS, AND OKANOGAN COUNTIES

SCIENTIFIC NAME	COMMON NAME	CLASS ¹	OCCURRENCE ²
Abutilon theophrasti	Velvet-leaf	Α	CH, DG, OK
Carduus pycnocephalus	Italian-thistle	Α	CH, DG, OK
Carduus tenuiflorus	Slenderflower-thistle	Α	CH, DG, OK
Centaurea calcitrapa	Purple starthistle	Α	CH, DG, OK
Centaurea macrocephala	Bighead knapweed	Α	CH, DG, OK
Centaurea nigrescens	Vochin knapweed	Α	CH, DG, OK
Crupina vulgaris	Common crupina	Α	CH, DG, OK
Euphorbia oblongata	Eggleaf spurge	Α	CH, DG, OK
Helianthus ciliars	Texas blueweed	Α	CH, DG, OK
Heracleum mantegazzianum	Giant hogweed	Α	CH, DG, OK
Hieracium floribundum	Yellow devil hawkweed	Α	CH, DG, OK
Hydrilla verticillata	Hydrilla	Α	CH, DG, OK
Isatis tinctoria	Dyers woad	Α	CH, DG, OK
Mirabilis nyctaginea	Wild four-o-clock	Α	CH, DG, OK
Peganum harmla	Peganum	Α	CH, DG, OK
Salvia aethiopis	Mediterranean sage	Α	CH, DG, OK
Salvia pratensis	Meadow clary	Α	CH, DG, OK
Salvia scalrea	Clary sage	Α	CH, DG, OK
Silybium marianum	Milk-thistle	Α	CH, DG, OK
Solanum elaeagnifolium	Silverleaf nightshade	Α	CH, DG, OK
Solanum rostratum	Buffalo-bur	Α	CH, DG, OK
Soliva sessilis	Lawnweed	Α	CH, DG, OK
Sorghum halepense	Johnson grass	A	CH, DG, OK
Spartina patens	Salt-meadow cordgrass	Α	CH, DG, OK
Spartium junceum	Spanish broom	A	CH, DG, OK
Tamarix ramosissima	Saltcedar	A	CH, DG, OK

Table 3-12. State-listed Noxious Weeds Found in Chelan, Douglas, and Okanogan Counties (continued)

SCIENTIFIC NAME	COMMON NAME	CLASS ¹	OCCURRENCE ²
Thymelaea passerina	Spurge-flax	А	CH, DG, OK
Zygophyllum fabago	Syrian bean-caper	Α	CH, DG, OK
Centaurea diffusa	Diffuse knapweed	Additional	CH
Centaurea repens	Russian knapweed	Additional	CH
Cirsium arvense	Canada thistle	Additional	CH
Kochia scoparia	Kochia	Additional	CH
Linaria vulgaris	Linaria vulgaris	Additional	CH
Tribulus terrestris	Puncture vine	Additional	CH
Alhagi maurorum	Camelthorn	B-Designate	CH, DG
Alopecurus myosuroides	Black grass	B-Designate	CH, DG
Amorpha fruticosa	Indigo bush	B-Designate	CH, DG
Anchusa arvensis	Annual bugloss	B-Designate	CH, DG
Anchusa officinalis	Common bugloss	B-Designate	CH, DG
Anthriscus sylvestris	Wild chervil	B-Designate	CH, DG
Bryonia alba	White byrony	B-Designate	CH, DG
Cabomba caroliniana	Fanwort	B-Designate	CH, DG
Carduus acanthoides	Plumeless-thistle	B-Designate	CH, DG, OK
Carduus acamnotaes Carduus nutans	Musk thistle	B-Designate	CH, DG, OK
Carauus nuuns Cenchrus longispinus	Longspine sandbur	B-Designate	CH, DG
Centaurea biebersteinii	Spotted knapweed	B-Designate	CH, DG
Centaurea diffusa	Diffuse knapweed	B-Designate	OK
Centaurea atgusa Centaurea jacea	Brown knapweed	B-Designate	CH, DG
Centaurea jacea x nigra	Meadow knapweed	B-Designate	CH, DG
Centaurea jacea x nigra Centaurea maculata	Spotted knapweed	B-Designate	CH
Centaurea macaiaia Centaurea nigra	Black knapweed	B-Designate	CH, DG
Centaurea nigra Centaurea solstitialis	Yellow star-thistle	B-Designate	CH, DG, OK
Ceniaurea soisinanis Chaenorrhinum minus	Dwarf snapdragon	B-Designate	CH, DG, OK
	Rush skeletonweed	B-Designate B-Designate	CH, DG
Chondrilla juncea	Yellow nutsedge	B-Designate	CH, DG
Cyperus esculentus	Scot's broom	B-Designate B-Designate	CH, DG, OK
Cytisus scoparius	Wild carrot	B-Designate B-Designate	CH, DG, OK CH, DG
Daucus carota	Blueweed	B-Designate B-Designate	CH, DG CH, DG
Echium vulgare	Brazilian elodea	_	CH, DG CH, DG
Egeria densa	Garden rocket	B-Designate B-Designate	CH, DG CH, DG
Eruca vesicaria ssp. sativa		<u> </u>	
Euphorbia esula	Leafy spurge	B-Designate	CH, DG, OK
Geranium robertianum	Herb-robert Polar hawkweed	B-Designate	CH, DG
Hieracium atratum		B-Designate	CH, DG CH, DG
Hieracium auranticum	Orange hawkweed	B-Designate	
Hieracium caespitosum	Yellow hawkweed	B-Designate	CH, DG
Hieracium laevigatum	Smooth hawkweed Mouse-ear hawkweed	B-Designate	CH, DG
Hieracium pilosella		B-Designate	CH, DG
Hypochaeris radicata	Spotted cats-ear	B-Designate	CH, DG
Impatiens glandulifera	Policeman's helmet	B-Designate	CH, DG
Lepidium latifolium	Perennial pepperweed	B-Designate	CH, DG
Lepyrodiclis holosteoides	Lepryodiclils	B-Designate	CH, DG
Leucanthemum vulgare	Ox-eye daisy	B-Designate	CH, DG
Linaria dalmatica	Dalmatian toadflax	B-Designate	CH, DG, OK
Lysimachia vulgaris	Garden loosestrife	B-Designate	CH, DG
Lythrum salicaria	Purple loosestrife	B-Designate	CH, DG, OK
Lythrum virgatum	Wand loosestrife	B-Designate	CH, DG
Myriophyllum aquaticum	Parrotfeather	B-Designate	CH, DG
Myriophyllum spicatum	Eurasian water milfoil	B-Designate	CH
Onopordum acanthinum	Scot thistle	B-Designate	CH, DG, OK

TABLE 3-12. STATE-LISTED NOXIOUS WEEDS FOUND IN CHELAN, DOUGLAS, AND OKANOGAN COUNTIES (CONTINUED)

SCIENTIFIC NAME	COMMON NAME	CLASS ¹	OCCURRENCE ²
Picris hieraciodes	Hawkweed ox-tongue	B-Designate	CH, DG
Potentilla recta	Sulfur cinquefoil	B-Designate	CH, DG
Rorippa austriaca	Austrian field cress	B-Designate	CH, DG
Senecio jacobaea	Tansy ragwort	B-Designate	CH, DG
Shaerophysa salsula	Swainson-pea	B-Designate	CH, DG
Sonchus arvensis	Perennial sow thistle	B-Designate	CH, DG
Spartina alterniflora	Smooth cordgrass	B-Designate	CH, DG
Spartina anglica	Common cordgrass	B-Designate	CH, DG
Torillis arvensis	Hedgeparsley	B-Designate	CH, DG
Ulex europaues	Gorse	B-Designate	CH, DG
Anchusa officinalis	Common bugloss	New Invader	OK
Cardaria draba	White-top	New Invader	OK
Hieracium auranticum	Orange hawkweed	New Invader	OK
Hieracium caespitosum	Yellow hawkweed	New Invader	OK
Linaria vulgaris	Linaria vulgaris	New Invader	OK
Polygonum cuspidatum	Japanese knotweed	New Invader	OK
Senecio jacobaea	Tansy ragwort	New Invader	OK

¹ A = State recommends mandatory eradication, B = State recommends mandatory control, Additional = Requires control by specific counties, New Invader = Not yet formally recognized as weeds, but considered a serious threat

3.5 WILDLIFE

Key Terms

Candidate Species – As defined by NMFS, candidate species are wildlife, fish, or plants being considered for listing as endangered or threatened, but for which more information is needed before they can be proposed for listing.

Endangered Species – A species of plant, fish, or wildlife which is in danger of extinction throughout all or a significant portion of its range.

Habitat Improvement – Management of wildlife or fish habitat to increase its capability for supporting wildlife or fish.

Listed Species – Wildlife, fish, or plants that are identified as either threatened or endangered within a region, State, or nation. Federally listed species are listed by USFWS or NMFS and consequently receive statutory protection throughout areas where their populations are in decline under the Endangered Species Act.

Mitigation – Measures designed to counteract environmental impacts or make impacts less severe. These measures may include amending an impact by not taking a certain action or part of an action; minimizing an impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; or compensating for the impact by replacing or providing substitute resources or environment.

Monitoring – HCP monitoring consists of two types: (1) compliance monitoring, in which NMFS monitors the permittee's implementation of the requirements of the HCP, incidental take permit terms and conditions, and implementation agreement, if applicable; and (2) effects and effectiveness monitoring, in which the permittee (or other designated entity) examines the impacts of the authorized incidental take (effects) and implementation of the operating conservation program to determine if the actions are producing the desired results (effectiveness).

Old-Growth Forest – A forest stand characterized by trees well past the age of maturity (dominant trees exceed 200 years of age). Stands exhibit declining growth rates and signs of decadence such as dead and dying treees, snags, and downed woody material.

* See Chapter 7 for a complete listing of all Key Terms.

² CH = Chelan County, DG = Douglas County, OK = Okanogan County Source: State Noxious Weed Board.

This section describes the wildlife-related licensing requirements and aquatic and shoreline wildlife species that are present in the project area, the tributaries, and in the Columbia River system. Wildlife conservation measures currently being conducted by the Chelan and Douglas County PUDs are described followed by threatened, endangered, and sensitive wildlife species that may occur in the vicinity of the project area and tributaries.

3.5.1 WILDLIFE-RELATED LICENSE REQUIREMENTS

Existing licenses for the Wells, Rocky Reach, and Rock Island Projects include the provision that FERC may require modifications to dam features and operations and/or require certain new facilities for the purpose of conserving wildlife resources (Article 31, FERC 1957a; Article 41, FERC 1962a; Article 15, FERC 1975a). Additional license requirements that are specific to individual projects are described below. For Wells, the Douglas County PUD must (1) provide funds for wildlife research and mitigation projects related to project operations (Article 41, FERC 1975b); and (2) in cooperation with WDFW, produce an annual progress report on the wildlife mitigation program (Article 41, FERC 1975b). For Rocky Reach, Chelan County PUD must provide funds for wildlife research and mitigation projects related to project operations (Article 32, FERC 1957a). For Rock Island, Chelan County PUD must conduct mitigation and monitoring activities, as deemed necessary, for bald eagles, Canada geese, and wood ducks (Articles 404-407, FERC 1989a).

3.5.2 AQUATIC WILDLIFE

3.5.2.1 Project Area

The project area provides habitat for a variety of waterfowl and aquatic furbearers. Waterfowl use of the reservoirs is mostly for wintering habitat. Up to 17,000 ducks and geese have been observed overwintering on Rocky Reach

reservoir, and 2,000 to 5,000 ducks and geese were observed overwintering on Rock Island reservoir (BPA et al. 1995b, River System Operation Review, Appendix N). Numbers of wintering ducks and geese at Wells reservoir are unknown. Common winter residents, by relative abundance, are American coots (*Fulica americana*), American wigeons (*Anas americana*), Canada geese (*Branta canadensis*), greater/lesser scaup (*Aytha* spp.), mallards (*Anas platyrhynchos*), and ring-necked ducks (*Aythya collaris*).

Other wintering waterfowl include gadwalls (Anas strepera), northern shovelers (Anas clypeata), buffleheads (Bucephala albeola), Barrow's goldeneyes (Bucephala islandica), ruddy ducks (Oxyura jamaicensis), common mergansers (Mergus merganser), and teal (Anas spp.). Common loons, pied-billed grebes (Podilymbus podiceps), eared grebes (Podiceps nigricollis), and western/Clark's grebe (Aechmophorus occidentalis) have been noted using the reservoirs.

Breeding waterfowl are mostly Canada geese, mallards, and common mergansers (*Mergus merganser*). Each year about 95 Canada geese pairs nest on Rock Island reservoir, 57 geese nest on Rocky Reach reservoir, and 84 geese nest on Wells reservoir (Fielder 1997; Hallet 1994, 1995, 1996, 1997). Nest sites are on islands and in goose nesting structures maintained by Chelan County PUD and WDFW. An unknown number of mallards and common mergansers also nest on islands and backwater areas along the reservoirs. Wildlife management areas, established as mitigation for hydroelectric project operation, as well as shoreline orchards and residential lawns, provide waterfowl brooding and grazing areas.

Other breeding waterfowl in the project area include wood ducks (*Aix sponsa*), which nest in natural and artificial nesting structures along Rock Island and Wells reservoirs. The Chelan County PUD maintains 92 wood duck nesting structures along the Rock Island reservoir, and WDFW maintains about 100 wood duck boxes

along the Wells reservoir. Wood duck nest boxes are not present along the Rocky Reach reservoir, and wood ducks are not known to nest in this area. Nesting habitat for cinnamon teal (*Anas cyanoptera*), green-winged teal (*Anas crecca*), gadwalls, pied-billed grebes, and coots is provided in reservoir backwater areas, although specific information on breeding occurrence is lacking for these species.

Aquatic furbearers present in the project area include beavers (*Castor canadensis*), muskrats (*Ondatra zibethicus*), and mink (*Mustela vison*). River otters (*Lutra canadensis*) are also present, but less common. Riparian vegetation, especially cottonwoods, willows, and emergent vegetation in backwater areas, provides important habitat for these species.

3.5.2.2 Associated Tributaries and Columbia River System

The lower reaches of the Wenatchee, Entiat, Methow, Okanogan, and Chelan Rivers, as well as the Columbia River system contain habitat similar to that of the project area (the Mid-Columbia River from the tailrace of Rock Island Dam to the tailrace of Chief Joseph Dam). Species expected to be present in these areas are the same as for the project area.

3.5.3 SHORELINE WILDLIFE

3.5.3.1 Project Area

Much of the shoreline adjacent to the reservoirs has been developed for fruit orchards. Wetland and riparian vegetation is limited and in some cases is artificially developed and maintained as a mitigation and licensing requirement for previous Federal and public utility actions. Shoreline areas and islands that provide dense riparian vegetation and protected areas for wildlife include the Rock Island Ponds, Turtle Rock Island, Earthquake Point, Daroga State Park at Rocky Reach reservoir, Bueana Bar, Cassimer Bar wetland, Washburn Pond, Park Island, Bridgeport Bar

Wildlife Area at Wells reservoir, and the numerous riparian areas of the Wells reservoir.

Wildlife species that use shoreline habitats include terrestrial mammals, birds, amphibians, and reptiles. Douglas County PUD funds WDFW to operate and manage several waterfowl and game bird habitat areas including the Bridgeport Bar, Central Ferry Canyon, Indian Dan, and Foster Creek wildlife areas. Mule deer (Odocoileus virginianus) inhabit range adjacent to each of the three reservoirs, and bighorn sheep (Ovis canadensis) are present near the Rocky Reach reservoir. The WDFW manages a big game winter area adjacent to the west shore of the downstream half of Rocky Reach reservoir. A deer fence, State Highway 97, and a railroad separate the winter range from the reservoir shoreline area, thus the project area is not an important component of the habitat base of big game herds.

The shoreline of the Wells reservoir, particularly the eastern shore, is not as developed as the other reservoirs in the project area due to a lack of access and because the PUD is the primary property owner for all of the lands immediately adjacent to Lake Pateros. This ownership pattern is unique to the Wells reservoir and provides extensive tracks of riparian and undisturbed shrub-step habitat for wildlife. These areas are used extensively by wintering mule deer and game birds. Douglas County PUD provides the primary funding to WDFW for the enhancement of mule deer habitat in Central Ferry Canyon, Indian Dan, and Foster Creek wildlife areas.

Other terrestrial mammals that use shoreline areas include a variety of bat species, small mammals, badgers (*Taxidea taxus*), striped skunks (*Mephitis mephitis*), and coyotes (*Canis latrans*). Shrubsteppe shorelines provide habitat for Great Basin pocket mice (*Perognathus parvus*), deer mice (*Peromyscus maniculatus*), and western harvest mice (*Reithrodontomys megalotis*), while talus slopes are used by yellow-bellied marmots (*Marmota flaviventris*), bushy-tailed woodrats (*Neotoma cinerea*), and Nuttall's cottontails

(*Sylvilagus nuttalli*). Riparian cottonwood, Ponderosa pine, and willow areas provide forage and cover for a variety of species.

Shorebirds found along the reservoirs include killdeer (Charadrius vociferus), spotted sandpipers (Actitis macularia), terns (Sterna spp.), herons, and gulls. Soras (Porzana carolina), and possibly Virginia rails (Rallus limicola), may nest in the emergent vegetation of the backwater areas, although this has not been confirmed. Upland game birds that use the project area shorelines are ring-necked pheasants (Phasianus colchicus), California quail (Lagopus californicus), chukars (Alectoris chukar), and mourning doves (Zenaidura macroura). Raptors that commonly nest in the vicinity of the reservoirs include red-tailed hawks (Buteo jamaicensis), American kestrels (Falco sparverius), ravens (Corvus corax), great horned owls (Bubo virginianus), osprey (Pandion haliaetus), bald eagle (Haliaeetus leucocephalus), and western screech-owls (Otus kennicottii). Cliffs and large cottonwoods and Ponderosa pines provide raptor nesting sites. Artificial nesting platforms established by Chelan County PUD also are used by some species, and nest boxes maintained by the Chelan County PUD and WDFW are used by kestrels.

Songbirds that use shoreline areas include the vellow warbler (Dendroica petechia), song sparrow (Melospiza melodia), marsh wren (Cistothorus palustris), cedar waxwing (Bombycilla cedrorum), Nashville warbler (Vermivora ruficapilla), MacGillivray's warbler (Oporornis tolmiei), solitary vireo (Vireo solitarius), warbling vireo (Vireo gilvus), Bullock's oriole (Icterus bullockii), Lazuli bunting (*Passerina amoena*), and western tanager (Piranga ludoviciana). Belted kingfishers (Ceryle alcyon) use willows and cottonwoods as hunting perches. The large cottonwoods and ponderosa pine provide perch and nest sites for raptors and woodpeckers. Riparian and wetland vegetation provide nest, forage, and cover habitat for songbirds. Fruit orchards are used by a

variety of birds, especially mourning doves (*Zenaida macroura*).

Amphibians likely to be present in wetland areas include Pacific treefrogs (*Hyla regilla*), tiger salamanders (*Ambystoma tigrinum*), long-toed salamanders (*Ambystoma macrodactylum*), Columbia spotted frog (*Rana luteiventris*), western toads (*Bufo boreas*), Great Basin spadefoots (*Scaphiopus intermontanus*), and bullfrogs (*Rana catesbiana*). Shallow backwater areas and temporary pools provide habitat for these species.

Reptiles present in project area include painted turtles (*Chrysemys picta*), western rattlesnakes (*Crotalus viridis*), gopher snakes (*Pituophis catenifer*), western fence lizards (*Sceloporus occidentalis*), western skinks (*Eumeces skiltonianus*), rubber boas (*Charina bottae*), and western terrestrial and common garter snakes (*Thamnophis* spp.). Some of these species are closely associated with wetlands (i.e., painted turtles) while others are more common along rocky and talus shorelines (i.e., rubber boas).

3.5.3.2 Associated Tributaries

In the upper reaches of the Wenatchee, Entiat, Methow, and Okanogan Rivers, and in the tributaries of these rivers, faster flowing, small streams bordered by riparian forest are present. These upper reaches provide habitat for a variety of riparian forest and stream associated wildlife, such as American dippers (*Cinclus mexicanus*), Steller's jays (*Cyanocitta stelleri*), ruby-crowned kinglets (*Regulus calendula*), and tailed frogs (*Ascaphus truei*). The tributaries of the Wenatchee, Entiat, Methow, and Okanogan Rivers extend into remote areas where species such as bobcats (*Lynx rufus*) and mountain lions (*Felis concolor*) are expected to be more common than in developed areas.

3.5.3.3 Columbia River System

The Columbia River system is a vast area that includes approximately 1,200 river miles and a

wide variety of associated habitats, including estuarine areas, riparian coniferous forests, riparian hardwood forests, wetlands, rocky cliffs, and shrub-steppe habitats. Wildlife present in this large, complex system include many of the wildlife species that occur in the Pacific Northwest. Species include marine mammals; estuarine shorebirds; riparian-forest-associated birds and mammals; and shrub-steppe- and cliffassociated wildlife such as northern sagebrush lizards (Sceloporus graciosus graciosus), bighorn sheep (Ovis canadensis), and golden eagles (Aquila chrysaetos). More detailed information on wildlife present in the Columbia River System is available in Appendix N of the Columbia River System Operation Review (BPA et al. 1995b).

3.5.4 WILDLIFE AND HABITAT ENHANCEMENT AND MONITORING

Chelan County PUD conducts a variety of wildlife and habitat enhancement and monitoring projects on the Rock Island and Rocky Reach reservoirs (Table 3-13). These include installing and maintaining goose nesting structures and wood duck nest boxes; conducting waterfowl, goose, and eagle surveys; and protecting riparian habitat. Some of these activities are required as part of licensing and settlement agreements, while others are voluntary. Habitat enhancement and monitoring projects on the Wells reservoir are conducted by WDFW, as part of a 1974 Settlement Agreement between Douglas County PUD and WDFW. These activities include protection of riparian areas, maintenance of goose nesting structures and goose nesting islands, construction and maintenance of wood duck nesting boxes, upland game bird habitat enhancement and feeding, planting of food plots for overwintering waterfowl, and habitat enhancement for overwintering mule deer herds.

3.5.5 PISCIVOROUS BIRD CONTROL ACTIVITIES

Studies indicate that gulls, cormorants, terns, and other piscivorous birds prey on juvenile salmonids (Mace 1983; Wood 1987; Schreck et al. 1997; Shreck and Stahl 1998; Collis et al.

1999, 2001). In spring 1982, gulls were found to consume 2 percent of the migrating salmon at the Wanapum Dam along the Mid-Columbia River (Ruggerone 1986). In the Columbia River estuary, Caspian terns (*Sterna caspia*) consumed approximately 12 percent of the outmigrating salmon smolt in 1997 (WDFW 2000). Ryan et al. (2001) found that 4.2 percent of PIT-tagged salmonids released in the Columbia River Basin in 2000 were detected from piscivorous bird colonies in the basin.

At the Wells, Rocky Reach, and Rock Island dams, prevalent avian predators include California gulls (Larus californicus), ring-billed gulls (L. delawarensis), and Caspian terns (USDA Animal and Plant Health Inspection Service [APHIS], unpublished data). At the Wells Hatchery, double-crested cormorants (*Phalacrocorax auritus*), common mergansers (Mergus merganser), herons (great blue heron [Ardea herodias] and black-crowned night heron [Nycticorax nycticorax]), and belted kingfishers (Ceryle alcyon) are the most abundant predators of salmonid smolt (APHIS, unpublished data). Quantitative data are not available on salmonid mortality by avian predators at the Wells Dam, Rocky Reach Dam, Rock Island Dam, or Wells Hatchery.

Chelan County PUD (in conjunction with the University of Washington, WDFW, and NMFS) is currently assessing the impacts of piscivorous birds on juvenile migrating salmonids.

To minimize bird predation on salmonids at the Wells, Rocky Reach, and Rock Island dams and the Wells Hatchery, Chelan and Douglas County PUDs fund avian predator control programs. These programs are implemented by APHIS, as outlined in the Cooperative Service Agreements between the PUDs and the APHIS. Control activities are based on an integrated wildlife damage management approach in which the most practical and appropriate methods to resolve wildlife conflicts are selected. Control methods emphasize non-lethal techniques, including hazing (i.e., propane canons, pyrotechnics, and

TABLE 3-13. RECENT AND ONGOING HABITAT MITIGATION AND ENHANCEMENT PROJECTS IN THE PROJECT AREA

Project	LICENSE REQUIREMENT
Wells	
In 1974, the Douglas County PUD gave WDFW over 5,000 acres of land and provided funding to manage the area for wildlife	yes
The Douglas County PUD voluntarily provides supplemental annual funding, and has since 1995	no
Erect raptor poles (1984 pool raise agreement)	yes
Dike sloughs and provide flow restriction gates at Cassimer Bar to control/minimize water level fluctuations within the wetland areas of the wildlife area	yes
Conduct winter-time bald eagle surveys	no
Spray noxious weeds on the Project lands along the reservoir	no
Rocky Reach	
Erect and maintain 28 artificial goose nesting structures	no ¹
Conduct goose nesting surveys (4-5 per year)	no ¹
Provided \$700,000 to WDFW for purchase of 20,000 acres of wildlife winter range	yes
Funded a 3-year mule deer habitat use study (\$145,000)	no ¹
Conduct winter bald eagle surveys	no ¹
Wrap mature riparian trees for protection from beavers	no ¹
Contract botanist to conduct rare and sensitive plant survey	no ¹
Spray noxious weeds on the Project lands along the reservoir	no ¹
Maintain three upland bird feeders along the reservoir	no ¹
Purchased 70 acres of wildlife habitat lands bordering the reservoir	no ¹
Rock Island	
Erect and maintain 23 artificial goose nesting structures	10 required
Conduct wood duck and goose nesting surveys (4-5 per year)	no ¹
Erect and maintain 92 wood duck nest boxes	60 required
Erect 6 raptor perch sites	no ¹
Conduct winter bald eagle surveys and monitor effect of recreation on bald eagles	no ¹
Wrap mature riparian trees for protection from beavers	no ¹
Conduct controlled burn to suppress noxious weeds and improve goose nesting and brooding areas on islands	no ¹
Fence a riparian corridor on Rock Island Creek to protect habitat from cattle overgrazing	no ¹
Purchase and manage 43 acres of riparian wildlife habitat	yes
Preserve 960 acres of Home Water Company property for wildlife habitat preservation	yes
Acquisition, creation of wetlands and management of 107 acres at river confluence	yes
Rehabilitated seven natural springs to improve water availability for wildlife	yes

¹ Although this specific activity was not required as part of Chelan County PUD's licensing requirements, the license does require the PUD to conduct wildlife mitigation activities.

non-target shooting) and overhead wire exclusion systems. The overhead wires span the tailrace of each dam and the hatchery rearing ponds, and inhibit bird access to fish (Figure 3-13). When necessary, lethal methods, which include direct shooting of target individuals, supplement non-lethal methods.

Ring-billed gulls are the primary species targeted for control activities, with other gulls, doublecrested cormorants, mergansers and other diving ducks, and Caspian terns also being frequently controlled (APHIS, unpublished data). The number of birds hazed or killed in a given year varies greatly. For example, at the Rock Island Dam, annual hazing levels of ring-billed gulls ranged from 450 instances to 3,371 instances between 1996 and 2001. (A hazing instance is defined as hazing of one bird during one site visit. For example, if an individual bird were to return to a site four times and was hazed during each visit, the number of hazing instances would be four.) During this same time period, from 201 to 1,075 ring-billed gulls were killed annually at the Rock Island Dam.

3.5.6 THREATENED AND ENDANGERED SPECIES

This section describes Federally and State-listed threatened, endangered, and sensitive wildlife species in the project area and associated tributaries. State priority habitats are also discussed. In addition, a brief description of Federally and State-listed threatened or endangered species in the Columbia River system is provided.

3.5.6.1 Federally Listed Species

Project Area

Only one Federally listed threatened species, the bald eagle, is known to occur in the project area (WDFW 1999). Northern spotted owls, gray wolves, and grizzly bears all occur in the nearby Wenatchee National Forest, Okanogan National Forest, and Colville Indian Reservation, but there

are no records for these species in the aquatic and riparian habitats of the project area (WDFW 1999).

Associated Tributaries

Five Federally listed threatened or endangered species are known to occur in the riparian and aquatic habitats of the project area tributaries (Wenatchee, Entiat, Methow, and Okanogan Rivers, and their associated tributaries) (Table 3-14). These species include the bald eagle (threatened), northern spotted owl (threatened), gray wolf (endangered), and grizzly bear (threatened).

Bald Eagle

Bald eagles generally occur along shores of saltwater and freshwater lakes and rivers that support substantial prey densities (generally anadromous fish or waterfowl) (Livingston et al. 1990; Stalmaster 1987). Breeding bald eagles use large trees for nesting that are generally within a mile of water and have an unobstructed view of water (ODFW 1996; Anthony and Isaacs 1989). Nest trees are usually within old-growth or residual old-growth stands, but some nesting also occurs in riverine forests dominated by cottonwood (*Populus* spp.) (ODFW 1996). Both breeding and wintering bald eagles forage over open water and use riparian trees for perching.

Two nesting bald eagle sites are known to occur in the vicinity of the project area. Since 1995, a nest site near Rocky Reach reservoir has been active each year (Fielder 1999 personal communication) and a nest site near Wells Dam has been intermittently active (Stoefel 1999 personal communication). Nesting eagles in the project area prey primarily on waterfowl. Wintering bald eagles are more common than nesting eagles in the project area.

Wintering bald eagle use averages about 12 eagles at Rock Island reservoir, 50 eagles at Rocky Reach reservoir, and 22 eagles at Wells reservoir (Fielder 1999 personal communication; Hallett 1994, 1995, 1996, 1997). Waterfowl, especially coots, are the main food source of wintering bald eagles in the area. Cottonwood

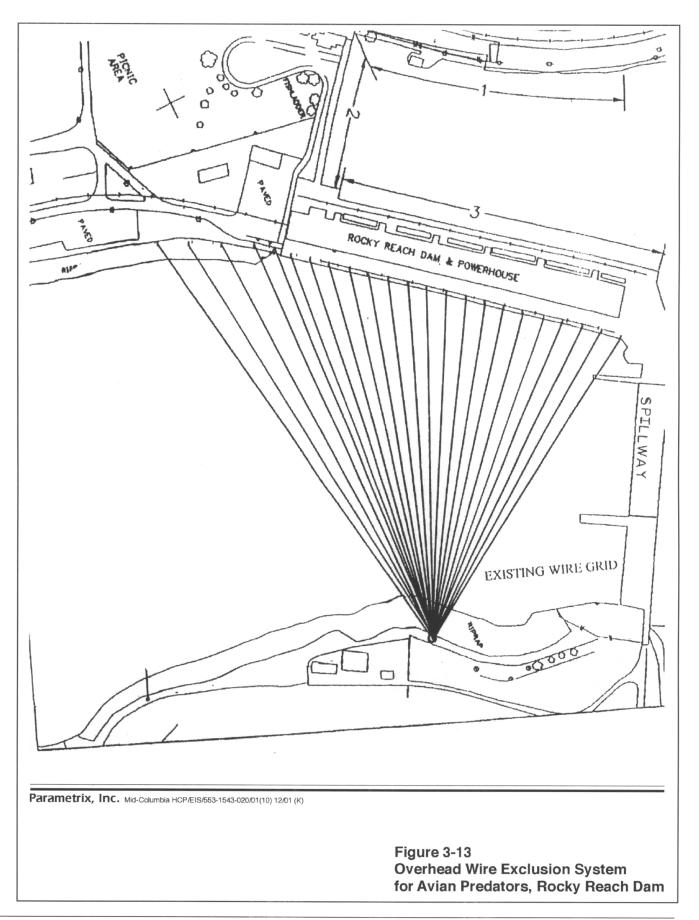


TABLE 3-14. THREATENED, ENDANGERED, AND SENSITIVE WILDLIFE SPECIES OCCURRING IN THE MID-COLUMBIA PROJECT AREA AND ASSOCIATED TRIBUTARIES

	OCCURRENCE ¹						
	FEDERAL	STATE	PROJECT		TRIBU	JTARIES	
	STATUS ²	STATUS ³	AREA ⁴	WENATCHEE ⁵	ENTIAT ⁵	METHOW ⁵	OKANOGAN ⁵
Mammals							
California bighorn sheep (Ovis canadensis)	SC	none	yes	yes	yes	no	yes
California wolverine (<i>Gulo gulo</i>)	SC	С	no	yes	no	yes	no
Canada lynx (<i>Lynx canadensis</i>)	Р	Т	no	yes	yes	yes	yes
Fringed myotis (<i>Myotis thysanodes</i>)	SC	M	no	yes	no	no	no
Gray wolf (<i>Canis lupus</i>)	Е	E	no	yes	yes	yes ⁶	no
Grizzly bear (<i>Ursus arctos</i>)	Т	Е	no	yes	yes	yes	yes
Long-eared myotis (<i>Myotis evotis</i>)	SC	M	no	no	no	no	no
Long-legged myotis (Myotis volans)	SC	M	no	no	no	yes	no
Pacific fisher (<i>Martes pennanti</i>)	SC	Е	no	no	no	no	no
Townsend's big-eared bat (<i>Plecotus townsendii</i>)	SC	С	no	no	no	no	no
Small-footed myotis (<i>Myotis ciliolabrum</i>)	SC	M	N/A	N/A	N/A	N/A	N/A
Spotted bat (Euderma maculatum)	none	M	no	no	no	no	yes
Western gray squirrel (Sciurus griseus)	SC	T	no	no	no	yes	yes
Yuma myotis (<i>Myotis yumanensis</i>)	SC	none	no	no	no	no	no
Birds							
American white pelican (Pelecanus erythrorhynchos)	None	E	yes	no	no	no	yes
Bald eagle (<i>Haliaeetus</i> <i>leucocephalus</i>)	Т	Т	yes	yes	no	yes	yes
Black tern (<i>Chlidonias niger</i>)	SC	М	N/A	N/A	N/A	N/A	N/A
Black-backed woodpecker (Picoides arcticus)	none	С	no	no	no	yes ⁶	no
Burrowing owl (Speotyto cunicularia)	SC	С	no	no	no	no	yes

TABLE 3-14. THREATENED, ENDANGERED, AND SENSITIVE WILDLIFE SPECIES OCCURRING IN THE MID-COLUMBIA PROJECT AREA AND ASSOCIATED TRIBUTARIES (CONTINUED)

	OCCURRENCE ¹						
		S-4	Door		TRIBU	JTARIES	
	FEDERAL STATUS ²	STATE STATUS ³	PROJECT AREA ⁴	WENATCHEE ⁵	ENTIAT ⁵	METHOW ⁵	OKANOGAN ⁵
Columbian sharp-tailed grouse (Tympanuchus phasianellus)	SC	Т	yes	no	no	yes	yes
Common loon (<i>Gavia immer</i>)	none	С	yes	yes	no	no	yes
Ferruginous hawk (<i>Buteo regalis</i>)	SC	T	no	no	no	no	no
Flammulated owl (Otus flammeolus)	none	С	no	yes	no	no	no
Golden eagle (<i>Aquila chrysaetos</i>)	none	С	yes	no	no	yes	yes
Great blue heron (Ardea herodias)	none	M	yes	yes	no	no	yes
Great gray owl (Strix nebulosa)	none	M	no	no	no	yes	yes
Harlequin duck (Histrionicus)	SC	none	no	yes	no	yes	no
Little willow flycatcher (Empidonax traillii)	SC	none	N/A	N/A	N/A	N/A	N/A
Lewis' woodpecker (<i>Melanerpes lewis</i>)	none	С	no	yes	no	no	no
Loggerhead shrike (<i>Lanius Iudovicianus</i>)	SC	С	no	no	no	no	no
Northern goshawk (Accipiter gentilis)	SC	С	no	yes	yes	yes	no
Northern spotted owl (Strix occidentalis)	Т	Е	no	yes	yes	yes ⁶	no
Olive-sided flycatcher (Contopus borealis)	SC	none	N/A	N/A	N/A	N/A	N/A
Osprey (<i>Pandion haliaetus</i>)	none	M	yes	yes	yes	no	yes
Peregrine falcon	SC	Е	no	yes	no	yes	no
(Falco peregrinus)							
Pileated woodpecker (<i>Dryocopus pileatus</i>)	none	С	no	no	no	yes	yes
Red-necked grebe (<i>Podiceps grisegena</i>)	none	M	no	no	no	no	no
Sandhill crane (<i>Grus canadensis</i>)	none	E	yes ⁷	no	no	no	no
Three-toed woodpecker (Picoides tridactylus)	none	M	no	yes	no	yes	yes
Vaux's swift (<i>Chaetura vauxi</i>)	none	С	no	yes	no	no	no
Western bluebird (<i>Sialia mexicana</i>)	none	С	no	no	no	yes	no

TABLE 3-14. THREATENED, ENDANGERED, AND SENSITIVE WILDLIFE SPECIES OCCURRING IN THE MID-COLUMBIA PROJECT AREA AND ASSOCIATED TRIBUTARIES (CONTINUED)

	OCCURRENCE ¹							
	FEDERAL	STATE	PROJECT		TRIBUTARIES			
	STATUS ²	STATUS ³	AREA ⁴	WENATCHEE ⁵	ENTIAT ⁵	METHOW ⁵	OKANOGAN ⁵	
Western grebe (Aechmophorus occidentalis)	none	М	yes ⁷	no	no	no	no	
Western sage grouse (Centrocercus urophasianus)	SC	Т	no	no	no	no	no	
White-headed woodpecker (Picoides albolarvatus)	none	С	no	no	no	yes ⁶	no	
Amphibians								
Cascades frog (Rana cascadae)	SC	none	N/A	N/A	N/A	N/A	N/A	
Columbia spotted frog (Rana luteiventris)	SC	С	yes	yes	no	yes	yes	
Tailed frog (Ascaphus truei)	SC	M	no	yes	yes	yes	no	
Tiger salamander (<i>Ambystoma tigrinum</i>)	none	M	no	no	no	no	no	
Reptiles								
Northern sagebrush lizard (Sceloporus graciosus)	SC	none	no	no	no	no	no	
Mollusks								
Giant Columbia River limpet (<i>Fisherola nuttalli</i>)	none	С	no	no	no	yes	yes	
Giant Columbia River spire snail (Fluminicola columbiana)	SC	С	no	yes	no	yes	yes	
California floater (Anodonta californiensis)	SC	С	no	no	no	no	no	

Species presence or species habitat listed in WDFW records. For nongame species with no State status, this category is not applicable (N/A) because WDFW does not keep records for these species.

² E= Federally listed as endangered, T = Federally listed as threatened, P = proposed for listing, SC = species of concern.

³ E = State listed as endangered, T = State listed as threatened, C = candidate for State listing, M = State listed as priority species.

⁴ Includes aquatic and riparian areas from the tailrace of Rock Island Dam to the tailrace of Chief Joseph Dam.

⁵ Includes aquatic and riparian areas of the river and its tributaries.

⁶ USFS (1995) documented this species' presence in the area.

Fielder (1999 personal communication) documented this species' presence in the project area.

and ponderosa pine trees provide important perch sites for these eagles. Nesting and wintering bald eagles have also been observed in the lower reaches of the project area tributaries, where adequate nest and perch sites and concentrations of waterfowl are present (WDFW 1999).

Northern Spotted Owl

The northern spotted owl is associated with dense forests that contain structural features characteristic of old-growth forests (i.e., multiple canopy layers, large diameter live trees, and snags) (Thomas et al. 1990). On the east side of the Cascade Mountains, these owls forage mostly on small mammals, especially northern flying squirrels (*Glaucomys sabrinus*) and bushy-tailed woodrats (*Neotoma cinerea*) (Forsman et al. 1984). Northern spotted owls have been recorded in the upper reaches of the riparian forests in the Wenatchee and Entiat watersheds (WDFW 1999).

Gray Wolf

Gray wolves have been eliminated from most areas of Washington State, and their current range is strongly influenced by the presence/absence of humans and development (Johnson and Cassidy 1997). Within remote areas, they use a variety of habitats (Johnson and Cassidy 1997). Prey species include ground squirrels, hares, rabbits, deer, elk, and bighorn sheep (Ingles 1965). Gray wolves are not present in the project area vicinity and their presence in the tributary watersheds is limited to the extreme northern portions of the north Cascades (WDFW 1999).

Grizzly Bear

Grizzly bears are rare in Washington State, with a minimum of 10 to 20 bears estimated in the north Cascades and 26 to 36 bears in the Selkirk range (including Canada) (Johnson and Cassidy 1997). As with gray wolves, grizzlies are limited to remote environments, but within these areas, they utilize a variety of habitats (Johnson and Cassidy 1997). Grizzly bears are opportunistic, omnivores, and their diet includes fish, rodents, carrion, insects, and plants (Mealey 1980; Hamer et al. 1977). These bears are not present in the

project area vicinity and their presence in the tributary watersheds is limited to remote areas in the north Cascades and Canada.

<u>Federally Proposed Species and Species</u> of Concern

No wildlife or plant species currently proposed for Federal listing are known to breed or reside in the aquatic and riparian habitats of the project area, and one proposed species, the Canada lynx, occurs in the vicinity of the associated tributaries (WDFW 1999). There are 37 species of concern that potentially occur in the project area and associated tributaries (see Table 3-14) (WDFW 1999). Species of concern include 9 mammal species, 11 birds, 3 amphibians, 1 reptile, 2 mollusks, and 11 plant species. Most of these species are likely to be present in the immediate vicinity of the project area and tributaries. However, species associated with forested areas, small streams, and remote areas (i.e., California wolverine, Pacific fisher, burrowing owl, northern goshawk, and tailed frog) are not expected to occur in the project area, as suitable habitat is not available.

State-Listed Species

State threatened and endangered species present in both the project area and associated tributaries are the American white pelican, Colombian sharp-tailed grouse, and bald eagle (see Table 3-14) (WDFW 1999). In addition, the peregrine falcon, northern spotted owl, Canada lynx, gray wolf, grizzly bear, and western gray squirrel are known to occur in the immediate vicinity of the tributaries (WDFW 1999). One sandhill crane sighting was recorded in the mid-1970s in the project area, but no records for this species exist for the tributaries (Fielder 1999 personal communication; WDFW 1999). Provided below are State-listed species not previously discussed.

American White Pelican

American white pelicans are colonial nesters that usually breed on isolated islands in freshwater lakes (WDFW 1999). Nesting success is influenced by human disturbance, mammalian predators, flooding, and erosion. This species requires shallow waters for foraging, such as lake and river edges, and open areas within marshes (WDFW 1999). The prey base of American white pelicans consists of fish, amphibians, and crustaceans. Over 100 white pelicans regularly use the Wells reservoir from May to early October (Hallet 1994, 1995, 1996, 1997), and this species has also been recorded on the Okanogan River (WDFW 1999).

Sharp-tailed Grouse

The sharp-tailed grouse occurs in grasslands and shrub savanna (Smith et al. 1997). The species is in serious decline, due to conversion of its habitat to agriculture and other uses (Smith et al. 1997). Sharp-tailed grouse have been recorded near the shoreline of the Mid-Columbia and Okanogan Rivers (WDFW 1999). However, this species is predominantly associated with upland habitats.

Peregrine Falcon

The continental peregrine falcon is a rare and local breeder in eastern Washington (Smith et al. 1997). This species was formerly extirpated from the State, but is now being reintroduced at certain locations (Smith et al. 1997). The habitat associations of these reintroduced birds are not well understood. The single record of this species in the project and tributary vicinity is from a tributary of the Beaver Creek and the Methow watershed (WDFW 1999).

Canada Lynx

In Washington State, lynx are found above the 4,500 foot elevation in forested environments (WDFW 1991). The population dynamics of lynx are largely dependent on snowshoe hares, their main prey (WDFW 1991). When hare abundance is high, lynx densities are generally high as well; when hare abundance is low, lynx densities are generally low. Denning sites of lynx

are most often in mature forests older than 200 years (WDFW 1991). Lynx are not present in the project area, as suitable habitat is not available. However, lynx have been reported in the vicinity of the project area tributaries (WDFW 1999).

Western Gray Squirrel

In eastern Washington, western gray squirrels are found in walnut tree groves planted by early settlers (Ryan and Carey 1995). The walnuts provide the primary food source for the squirrels. Other factors important to western gray squirrels are availability of large trees for nesting and proximity to water (WDFW 1991). Western gray squirrels are not present in the project area, but do occur in riparian areas in the Methow and Okanogan watersheds (WDFW 1999).

Sandhill Crane

Sandhill cranes are found in large tracts of open habitat, where visibility is good from all vantage points (WDFW 1991). Nesting sites are generally in shallow water marshes that have dense emergent plant cover, and feeding grounds include meadows, grasslands, and grainfields (WDFW 1991). During 1976, Paul Fielder, wildlife biologist for Chelan County PUD, observed two sandhill cranes along the Wells reservoir, but no other records exist for this species in the project area or the associated tributaries (Fielder 1999 personal communication; WDFW 1999). This species is probably a rare migrant in the project area.

State Candidate and Monitor Species

State candidate species are species that are proposed for listing as threatened or endangered. Monitor species include wildlife species for which WDFW monitors status and distribution. Little is known about many of these species, but biologists are concerned about their well-being.

State candidate species known to occur in the project area include common loons and golden eagles (see Table 3-14) (WDFW 1999). In addition, burrowing owls, California wolverines,

Columbia spotted frogs, flammulated owls, Giant Columbia River limpets, Giant Columbia spire snails, black-backed woodpeckers, Lewis' woodpeckers, white-headed woodpeckers, northern goshawks, pileated woodpeckers, Vaux's swifts, and western bluebirds are known to occur in the aquatic and riparian habitat of the project area tributaries (WDFW 1999).

Two State monitor species, the osprey and great blue heron, occur in both the project area and their associated tributaries (WDFW 1999). Several osprey nests are located along the project area reservoirs and a great blue heron rookery is present near Rock Island reservoir (Fielder 1999 personal communication). Western grebes (monitor species) have been observed at the reservoirs and are likely to be present in the lower reaches of the project area tributaries. Four other State monitor species (the spotted bat, great gray owl, three-toed woodpecker, and tailed frog) are known to occur in the tributaries only (WDFW 1999).

State Priority Habitats

Riparian zones, wetlands, islands, talus slopes, cliffs/bluffs, and shrub-steppe habitats are present throughout the immediate vicinity of both the project area and associated tributaries. Waterfowl concentration areas occur along Wells, Rocky Reach, and Rock Island reservoirs, and in the lower reaches of the project area tributaries. Oldgrowth/mature forest, alpine and meadow habitats,

snag-rich areas, aspen stands, and high quality instream habitats are present, but rare, along the upper reaches of the project area tributaries.

3.5.6.2 Columbia River System

Federally listed threatened and endangered wildlife species that use aquatic and riparian habitats of the Columbia River System include the bald eagle, northern spotted owl, Steller sea lion (*Eumetopias jubatus*), and marbled murrelet (*Brachyramphus marmoratus*).

General habitat associations and habitat use of bald eagles and northern spotted owls are described in Section 3.5.5.1, Federally Listed Species. Marbled murrelets forage on inland saltwaters and on the ocean within 1.2 miles of shore (WDFW 1991). These birds nest in mature and old-growth forests within 50 miles of the ocean (WDFW 1991; Csuti et al. 1997). The Columbia River, at its confluence with the Pacific Ocean, provides foraging habitat for marbled murrelets, with possible breeding evidence here as well (Smith et al. 1997).

Steller sea lions occur in coastal waters and use rocky shorelines and islands for haul outs and rookeries. Their diet consists primarily of fish, squid, and octopus (Osborne et al. 1988). Their use of the Columbia River system includes a haul out at the mouth of the river (Brueggeman 1992) and occasional foraging in the Columbia River estuary.

3.6 LAND OWNERSHIP AND USE

3.6.1 PROJECT AREA

3.6.1.1 Wells Dam

Wells Dam, owned by Douglas County PUD, encompasses approximately 60 acres and includes the 4,460-foot dam, a powerhouse integrated into

the dam itself, transmission facilities, and a fish hatchery complex. The construction of Wells Dam created a 30-mile reservoir (Lake Pateros) encompassing approximately 9,740 acres. Wells reservoir provides approximately 98,000 acre-feet of usable storage and 331,200 acre-feet of total storage.

The Wells Project has a large fish hatchery located on the west side of the dam and another hatchery located on the Methow River near the town of Winthrop. The Methow Hatchery also has three fish acclimation ponds with one pond located on each of the main tributaries to the Methow River including a pond on the Chewuch and Twisp Rivers, and an acclimation pond located on the upper mainstem Methow River (see Figure 1-5). Recreational facilities were constructed as part of the dam project, and include Marina Park in Bridgeport, Columbia Cove Park in Brewster, Memorial Park in Pateros, and the Wells Dam Overlook Park next to the dam. The park at the dam site consists of lawn, picnic shelters, restrooms, an interpretive area, and a petroglyph display. The visitors center at Wells Dam includes historical and electrical displays and a fish viewing center. The other parks are described in more detail in Section 3.10, Recreation.

The area surrounding the Wells Dam is mostly privately owned land that is used for orchards, rangeland, and residences. Douglas County PUD owns most of the shoreline lands surrounding the Wells reservoir. The State and Douglas County PUD own and operate several wildlife areas in the vicinity of Wells Dam. They include the Foster Creek Wildlife Area, Bridgeport Bar Wildlife Area, Center Ferry Canyon Wildlife Area, Washburn Pond, Cassimer Bar, and the Indian Dan Wildlife Area. Federal lands managed by the BLM are located east (a small parcel close to the dam) and west (a larger parcel located 2 miles away) of the dam. Five miles to the northwest are the forest lands of the Okanogan National Forest. Bridgeport State Park is located approximately one mile to the east of Bridgeport. Recreation is a principal use near the dams and reservoirs.

Zoning in the vicinity of the Wells Dam and within Douglas County (between Chief Joseph Dam and Wells Dam) is 42 percent river irrigation agriculture, 30 percent dryland agriculture, 20 percent commercial agriculture, and 8 percent rangeland conservation. The north

side of the Columbia River in this same section is within Okanogan County, and is zoned minimum requirement district. This zoning classification is for all uses that are generally unrestricted.

3.6.1.2 Rocky Reach Dam

The Rocky Reach Dam complex, owned by Chelan County PUD, is spread over approximately 75 acres and includes the dam, powerhouse, visitor information center, fish hatchery, and park (Chelan County PUD 1997a). The 2,500-foot Rocky Reach Dam creates a 43-mile reservoir (Lake Entiat) encompassing approximately 8,235 acres. Rocky Reach's reservoir provides approximately 35,000 acre-feet of storage.

Fish-related facilities at the dam include passage structures and a fish hatchery. Rocky Reach also has a visitor information center and park. The visitor center attracts over 100,000 visitors annually. The visitor center has a lobby, restaurant, theatre, and fish viewing room. The facility also includes two interpretive museums: the Gallery of Electricity and the Gallery of the Columbia. The museum houses exhibits and displays that relate the early history along the Columbia River, the construction and operation of the dam, and a history of electricity and its generation. Adjacent to the information center is a 30-acre park featuring a picnic area, playground, lawn, and gardens.

A broad river valley surrounds the Rocky Reach Dam and there are several land uses located adjacent to the dam. These mainly include apple orchards that line both sides of the Columbia River. However, there are also private residences, a residential subdivision, some commercial uses, and Lincoln Rock State Park.

Similar to Wells Dam, Rocky Reach was required to develop parks and recreation areas. Daroga State Park, Lincoln Rock State Park, Orondo Park, Entiat Park, Chelan Falls Park, and Beebe Bridge Park are part of the Rocky Reach Project.

These parks are discussed in more detail in Section 3.10, Recreation.

State and Federally owned lands are also located in the vicinity of Rocky Reach. The Swakane State Wildlife Recreation area encompasses the area above and to the west of the dam site. Further west of the dam is Wenatchee National Forest land. Most of the land located east of the dam is privately owned, except for some interspersed Federal public lands that are managed by the BLM.

Zoning in the vicinity of the Rocky Reach Dam is commercial agriculture on the Douglas County side (east), and public lands and facilities on the Chelan County side (west).

3.6.1.3 Rock Island Dam

The Rock Island Dam complex, owned by Chelan County PUD, consists of a 3,800-foot dam, two powerhouses, transmission towers and lines, maintenance facilities, and offices. The dam is a run-of-the-river type that does not have significant water storage capacity (7,500 acre-feet of storage). However, the dam creates a 21-mile reservoir covering an area of approximately 3,300 acres (Chelan County PUD 1997b).

The dam complex's fish hatchery facilities are composed of a central hatchery located just upstream of Rocky Reach Dam and five satellite hatcheries located in the tributaries. As part of the dam's development, several recreational sites were constructed and became part of the dam's Federal operating license. These include Wenatchee Riverfront Park, Walla Walla Point Park, Wenatchee Confluence State Park, and Rock Island Hydro Park. These parks are discussed in more detail in Section 3.10, Recreation.

Land ownership and uses in the vicinity of the dam includes private, State, and Federal lands used for recreation, conservation, range land, and private residences. State and Federally owned lands are located generally east, west, and south of the dam. Approximately 3 miles south of the dam is the Colockum State Wildlife Recreation Area. Located east and west of the dam are public lands administered by the BLM. These Federal lands are mostly located along Rock Island Creek and Douglas Creek east of the dam and on Wenatchee Heights west of the dam, and are interspersed among privately owned land. Located a few miles north of the dam is the Alcoa aluminum plant. There are no adjacent land uses because of the steep bluffs located next to the Columbia River in this area.

Zoning along the Columbia River in the vicinity of the Rock Island Dam is dryland agriculture on the Douglas County side (east) and rural/industrial on the Chelan County side (west).

3.6.2 LICENSE REQUIREMENTS

The original licenses for the Wells, Rocky Reach, and Rock Island Projects include by reference general terms and conditions by FERC for major projects. These general conditions do not directly address land use, except for Article 8, which states:

In the construction and maintenance of the Project, the location and standards of roads and trails, other land uses, including the location of quarries, borrow pits, spoil disposal areas, and sanitary facilities, shall be subject to the approval of the department or agency of the United States having supervision over the lands involved.

Similarly, Article 48 for the Wells Hydroelectric Project provides the licensee the authority to grant permission for certain types of use and occupancy of project lands and waters if the proposed use and occupancy is consistent with the purposes of protecting and enhancing the scenic, recreational, and other environmental values of the project.

Subsequent amendments to the licenses have added specific requirements for public access for recreation, but do not otherwise address land use. Generally, the FERC licenses require licenses to allow public access, to a reasonable extent, to project waters and adjacent public lands for navigation and outdoor recreational purposes, including fishing and hunting.

3.6.3 ASSOCIATED TRIBUTARIES

The tributaries associated with the three dams mainly lie within a three county area that includes Douglas, Chelan, and Okanogan counties. Within this area, the main land use surrounding three of the major tributaries (Wenatchee, Entiat, and Methow Rivers) is the National Forest lands of the Wenatchee and Okanogan National Forests. Major land uses and ownership for each of the three counties is characterized below.

3.6.3.1 Chelan County

Approximately 80 percent of Chelan County is mountainous, sparsely to heavily forested and undeveloped. Much of the county's land area is reserved for conservation, habitat, forestry, and outdoor recreation, because either the USFS or National Park Service owns approximately 74 percent of the county. The State also owns several wildlife recreation areas including Swakane, Entiat, and Chelan Butte. The State also owns the Ice Caves Heritage area located north of Chelan.

The majority of development has largely been restricted to the narrow valley floors around the Wenatchee and Entiat Rivers and Lake Chelan. The major land use activity within the river valley areas of the Wenatchee and Entiat Rivers is agricultural, consisting largely of the production of apples, pears, and soft fruits. The amount of land used for agricultural purposes remains fairly constant. Although orchard lands are being converted to residential/commercial use in the urban fringe areas around Wenatchee, this trend is offset by expansion of irrigation districts to

previously unused land. The conversion of unused land to residential, agronomic, and recreational use is expected to continue.

Industrial development is limited. For the most part, industrial activities are located along the Columbia River in the Wenatchee/East Wenatchee urban area. There are some manufacturing activities within the agricultural areas, most of which are associated with the fruit production industry.

The main residential and commercial concentrations are located in and around the incorporated towns and cities. There are extensive year round and summer home developments along the shores of lower Lake Chelan and to lesser degree around Lake Wenatchee. Some limited tourist commercial activities are located along U.S. Highway 2 up through the Wenatchee valley. Leavenworth, at the upper end of the valley, has developed extensive tourist commercial facilities. Substantial residential growth has occurred in the Wenatchee area.

Zoning adjacent to the Wenatchee River, from the mouth at the Columbia River up to the town of Cashmere, is predominantly rural residential/ resource (RR5 and RR10) with a small amount of rural village (RV). Between the towns of Cashmere and Leavenworth, zoning adjacent to the river becomes predominantly commercial agricultural lands (AC), with smaller areas zoned rural residential/resource (RR2.5 and RR5) and rural village (RV). Within the towns of Cashmere and Leavenworth, zoning becomes city urban growth area (UGA). Beyond the town of Leavenworth, the Wenatchee River runs through the Wenatchee National Forest to its source at Lake Wenatchee, with the exception of the land surrounding the town of Plain, which is outside of the Forest. This land is zoned primarily rural residential/resource (RR2.5, RR5, and RR20).

The majority of the Entiat River (the upper twothirds) is within the Wenatchee National Forest. Zoning adjacent to the Entiat River, from its mouth at the Columbia River up to the town of Ardenvoir, is predominantly commercial agricultural lands (AC). Beyond the town of Ardenvoir, up to the boundary of the Wenatchee National Forest, zoning is almost entirely rural residential/resource (RR5 and RR10).

3.6.3.2 Douglas County (Greater East Wenatchee)

Unlike Chelan County where most of the land is mountainous and therefore undeveloped, approximately 80 percent of the land in Douglas County is flat or rolling and suitable for agricultural purposes or range. The rolling plateau from Waterville to Banks Lake is primarily used for grain production, while the lowland areas are engaged in the production of apples, pears, and soft fruit. Near the Columbia River, there is a narrow floodplain that provides level areas where urban development and apple orchards have been established. The valley sides of the Columbia River are fairly steep, making them generally unsuitable for development.

In contrast to Chelan and Okanogan counties, Douglas County does not have a large percentage of Federal or State land ownership and thus most of the land is in private ownership. The State owns several wildlife recreation areas including the Central Ferry and Foster Creek State Wildlife Recreation areas. Federal lands (managed by the BLM) are scattered along the Columbia River and some drainage basins such as Rock Island Creek and Douglas Creek.

The greater East Wenatchee urban area is about 31,000 acres in size. About one-third of this area is comprised of residential uses with commercial and industrial land uses accounting for another 10 percent of the urban area. As stated previously, residential development in the East Wenatchee area has accelerated during the last 5 years and is a trend that is expected to continue.

3.6.3.3 Okanogan County

The western half of Okanogan County is dominated by dense, rugged, and mountainous terrain that comprises much of the Okanogan National Forest. Agricultural uses are concentrated in the central portion of the county mainly along the county's major river valleys of the Columbia, Okanogan, and Methow Rivers. The southeast corner of the county is covered by the extensive holdings of the Colville Indian Tribe.

Timber, habitat, conservation, and recreation are the main uses of the National Forest land in the county. These uses in particular surround the Methow River valley. The State also owns the Methow State Wildlife Recreation Area that rings the Methow River valley.

Agriculture, pasture, and residential ranches are some of the chief uses found in the unincorporated areas of the Methow and Okanogan river valleys. Similar to the other counties, apples, pears, and soft fruits are the main crops along with hay.

Residential areas are found primarily around the county's incorporated cities and towns, and in the larger unincorporated communities in the county. Commercial and industrial development is also found in the larger cities, such as Oroville, Tonasket, Omak, Okanogan, Brewster, Pateros, and Twisp. In particular, Omak, the county center for services and trade, is experiencing an increasing rate of growth.

The Methow and Okanogan Rivers are within Okanogan County. Both sides of the Methow River are zoned Methow Review District from the source to just north of the town of Methow (approximately 75 percent of the river corridor). This zoning classification requires more detailed review for proposed development projects than the other zoning classification in Okanogan County, which is minimum requirement district. The lower 25 percent of the Methow River

corridor and the entire length of the Okanogan River are zoned minimum requirement district.

3.6.4 COLUMBIA RIVER SYSTEM

The land ownership and uses in the Columbia River Basin are a reflection of the settlement pattern and history of the area. Native cultures were concentrated in the river valleys and early explorers reported populations of Indians as high as 50,000 along the Columbia and Snake Rivers. Particularly important locations were major fishing areas located around falls and rapids. Early settlers used the river system for transportation and trading settlements soon sprang up around the rivers.

In the late 1800s, fertile soils, abundant natural resources, liberal Federal land dispersal policies (Homestead Act, Donation Land Act, Timber Culture Act, and Desert Land Act), and development of the railroad all helped to spur development of interior areas of the State, particularly the Columbia Basin. One result of the U.S. Government's influence in settling the region was the granting of land for the railroad in the 1860s and 1870s. Congress made a series of land grants to the railroads each of which was 640 acres in size. However, these land grants alternated on either side of the rail lines. Many of the grants were sold off to private individuals or timber companies, while others were retained in Federal ownership. This resulted in a State-owned lands are generally managed for timber harvest, mining, wildlife habitat conservation, grazing, and recreation (Foster Wheeler 1995). There are a few relatively large areas of State ownership near the Columbia River and its tributaries and these are generally wildlife recreation areas. However, there are also lands that were granted to the State from the Federal government. These were grants of sections within each township (sections 16 and 36). As with the railroad grants, this has resulted in a checkerboard pattern of evenly scattered parcels.

checkerboard pattern of intermingled Federal and private land ownership (Foster Wheeler 1995) that still exists today.

In the early 1900s, large public works projects, particularly hydroelectric and irrigation, caused further development of both urban and agricultural areas such as Grand Coulee and Electric City. Cheap and abundant power also attracted wartime industries such as aluminum companies to the area in the 1940s.

In general, existing land uses typical of the Columbia River Basin include cropland, forest, range, and urban development. Cropland uses include pasture, orchards, nurseries, and dry and irrigated lands used to grow crops. Forestry uses include commercial timber harvest, wildlife habitat, and open space. Natural meadow areas and the dry shrub-steppe land cover are largely used as rangeland. Most of the commercial and industrial land uses are concentrated in the urban areas of the Columbia Basin.

Land ownership or management of property in the Columbia Basin is a mixture of Federal, State, private, and Tribal interests. More than 20 Federal agencies manage lands within the basin. The primary agencies are the USFS, BLM, National Park Service, USFWS, BOR, Army Corps of Engineers, and defense agencies, such as the U.S. Army, and U.S. Department of Energy (USDOE).

Indian Tribes also control large areas of the basin. These Tribes include the Yakama, Colville, and Spokane Tribes. Ownership of Tribal lands can be classified into three categories: (1) lands held in trust by the Tribal government or Federal Government, (2) lands allotted to individual Indians and now held as private Indian lands, or (3) lands allotted to individual Indians which were subsequently sold to non-Indians and now are in private ownership.

3.7 SOCIOECONOMICS

3.7.1 COUNTY DEMOGRAPHICS

The three project area counties are largely rural with relatively low population. In 2000, the population of Washington State was 5,894,121 while the populations of Chelan, Douglas, and Okanogan Counties were 66,616, 32,603, and 39,564 people, respectively (U.S. Census 2000). Together, the three counties contain just 2.4 percent of the State population while covering 10,010 square miles, or 15 percent of the State.

Since 1990, Washington State population increased by 1,580,520 or 26.8 percent. The study area counties have grown at a similar or slightly slower rate. During this period, Chelan County grew by 14,366 persons (27.4 percent), Douglas County by 6,398 (24.4 percent), and Okanogan County by 6,214 (18.6 percent) (U.S. Census 2000).

Future population growth for the three county areas is generally expected to exceed the Statewide rate of growth. By 2010, Washington State is expected to have 6,693,325 persons, 13.5 percent more than in 2000. Chelan County will reach 76,093 persons by 2010, a 14.2 percent increase from 2000. Douglas and Okanogan counties will increase 21.4 and 11.3 percent, respectively, over the same period to reach populations of 39,596 and 44,061 persons, respectively (Washington State Office of Financial Management 1995).

Statewide, 57 percent of the population lives in incorporated areas. Chelan County is roughly similar, with 45 percent of the population in incorporated places. Wenatchee is its largest city, with 27,856 persons in 2000. Other Chelan County cities and towns include Chelan (population 3,522 people), Cashmere (population 2,965 people), Leavenworth (population 2,074 people), and Entiat (population 957 people) (U.S. Census 2000).

Douglas and Okanogan counties are more rural, with 32 and 40 percent, respectively, of their population in incorporated areas. The largest cities in Douglas County are East Wenatchee (population 5,757 people), Bridgeport (population 2,059 people), and Waterville (population 1,153 people). In Okanogan County, the largest cities are Omak (population 4,721 people), Okanogan (population 2,484 people), and Brewster (population 2,189 people) (U.S. Census 2000).

The three project area counties have proportionately more persons of Hispanic origin (persons of Hispanic origin can be of any race) than the State as a whole, largely due to the amount and type of agricultural employment. Chelan, Douglas, and Okanogan counties were 19.3, 19.7, and 14.3 percent Hispanic, respectively, in 2000, compared to 4.4 percent for the entire State. Native American populations are low in Chelan and Douglas Counties, about 1 percent, but are 11.5 percent of the Okanogan County population due to the presence of the Colville Indian Reservation. Black, Asian, and other races are a small part of the area population (about 1 percent) (U.S. Census 2000).

3.7.2 TRIBAL DEMOGRAPHICS

This section briefly describes the demographics of the Indian Tribes that fish the Columbia River. These include the Confederated Tribes of the Colville Reservation (Colville Indians), Confederated Tribes and Bands of the Yakama Indian Nation (Yakama Indians), Confederated Tribes of the Umatilla Indian Reservation (Umatilla Indians), Confederated Tribes of Warm Springs Reservation (Warm Springs Indians), and Nez Perce Tribe. Of these reservations, only the Colville Reservation is located within the project area (Chelan, Douglas, or Okanogan counties).

The total population on each of the five project area reservations in the year 2000 was:

- 7,587 persons for the Colville Reservation,
- 31,799 persons for the Yakama Reservation,
- 2,927 persons for the Umatilla Reservation.
- 3,314 persons for the Warm Springs Reservation, and
- 17,563 persons for the Nez Perce Reservation (U.S. Census 2000).

There were 4,528 Native Americans (59.7) percent) on the Colville Reservation. Most of the remainder, 32.6 percent, were white. On the Yakama Reservation, 7,411 persons were Native American (23.3 percent), 10,605 persons (33.4 percent) were white, 422 persons (1.3 percent) were Asian, and 11,655 persons (36.7 percent) were classified as some other race. About half of the population or 1,427 persons (48.8 percent) of the Umatilla Reservation was Native American in 2000. Most of the rest (1,377 persons or 47 percent of the reservation population) were white. Most of the Warm Springs Reservation is peopled by Native Americans (91.7 percent) with a small percentage of whites (4.8 percent). Lastly, the Nez Perce Reservation is only 11.7 percent Native American with the majority of persons (84.6 percent) being white (U.S. Census 2000).

3.7.3 COUNTY ECONOMIES

Compared to Washington State, the project area counties have historically had higher unemployment and lower per capita income. Unemployment in 2000 in Chelan, Douglas, and Okanogan counties was 8.9, 7.5, and 10.9 percent, respectively, while the Statewide unemployment rate was 5.2 percent (Washington Employment Security Department 2000a). The Statewide average annual wage in 2000 was \$37,038, while in Chelan, Douglas, and

Okanogan counties average annual wage was \$23,874, \$20,896, and \$19,659, respectively (Washington Employment Security Department 2000b).

Consistent with their rural character, employment in the area counties is much higher in agriculture and forestry and lower in manufacturing compared to the entire State, where agriculture, forestry, and fishing comprise 2.3 to 3.4 percent of the jobs and manufacturing comprises 2.3 to 7.2 percent of State-wide employment (Table 3-15). Washington State is the nation's largest grower of apples, and the three counties produce 35 percent of the State's output. The apple industry has suffered in recent years. The value of the State's 1997 apple crop dropped \$90 million from the previous year, with production down about 9 percent. Growers harvested a record crop in 1998. Prices, however, declined sharply even though many apples were left on the tree. The price for processing apples was often below the cost of harvesting. Prices and demand have been affected by the Asian financial crisis and a tariff imposed by Mexico.

Other important fruits grown in the area include pears and sweet cherries. As a consequence of the high level of agriculture, employment varies substantially by season. Employment in government is similar to the rest of the State, but accounts for a much higher portion of the total wages paid. Employment in the service sector is lower than in the entire State.

3.7.3.1 Chelan County

In Chelan County, agriculture is the largest sector in terms of employment, although not in terms of wages paid due to the seasonal nature and large number of relatively low-skilled jobs (see Table 3-15). Fruit, led by apples, is the major crop. The primary fruit growing areas are along river valleys, where water is available for irrigation and natural air drainage produces a favorable climate.

TABLE 3-15. PERCENT TOTAL EMPLOYMENT AND WAGES PAID FOR SELECTED SECTORS, 1998

	Washington State		CHELAN COUNTY		Douglas County		OKANOGAN COUNTY	
	% TOTAL EMPLOY- MENT	% OF AVERAGE WAGE						
Agriculture, Forestry, Fishing	3.7	47.2	23.5	55.1	34.0	65.2	31.2	55.7
Manufacturing	14.4	127.7	7.2	147.8	2.3	108.7	5.4	139.4
Retail	17.8	54.2	16.9	68.1	17.3	75.1	12.6	72.4
Services	26.1	108.5	19.0	106.4	13.2	114.5	18.0	102.2
Government	17.0	102.4	16.2	148.5	19.7	156.1	20.3	163.5

Source: Washington State Office of Financial Management 2000

In the manufacturing sector, aluminum is the largest industry. This industry is made possible by the availability of large quantities of low-cost electricity. Wages in manufacturing are relatively high and contribute substantially to the County's economy.

In the service sector, health care is the leading industry and accounts for almost half of the sector's employment. This industry also pays relatively high wages. Hotels and lodging are also important in the services sector. Chelan County attracts a relatively large number of tourists and recreationalists, making lodging the second-largest industry in the sector. However, this industry is seasonal and pays relatively low wages, reducing its importance to the local economy.

The tourist industry also supports a substantial portion of the retail sector in Chelan County. In the government sector, local government related to education accounts for half of the employment. State government employment is split roughly between community colleges and the Department of Transportation. Federal employment is mostly related to land and wildlife management in the Wenatchee National Forest. All government-sector jobs are relatively well paid.

3.7.3.2 Douglas County

Agriculture dominates Douglas County employment. As in Chelan County, fruit growing is very important along river valleys, primarily the Columbia. Douglas County also has large areas on the Columbia Plateau where wheat is grown. Wheat production is both dry land and irrigated. Little manufacturing is based in Douglas County; however, some persons employed in manufacturing in the Wenatchee area (Chelan County) live across the Columbia in East Wenatchee (Douglas County).

As in Chelan County, most service-sector employment is in health care. Other service-sector and retail employment supports local businesses and residents and is less dependent on tourism than Chelan County. Government is the largest non-agricultural sector in Douglas County, and 87 percent of government employment is in local government, most of which is devoted to education.

3.7.3.3 Okanogan County

Okanogan County is the third-largest producer of apples in the State, after Yakima and Chelan counties. Other important fruit crops include

cherries and pears. The County also produces large amounts of grains, including wheat, barley, oats, and corn. Much of this agriculture requires irrigation during part of the year.

Okanogan County supports large numbers of livestock, including beef, sheep, and lambs. Forestry employment has declined recently due to harvest restrictions and is not expected to regain its once-substantial role. Manufacturing is a relatively small part of the County economy. Most of the manufacturing is tied to the timber and wood products industry, and hence has been volatile.

Similar to both Chelan and Douglas counties, health care is the largest industry in the service sector. Another major employer in the service sector is Tribal administration for the Colville Indian Reservation. Combined with the Colville Tribal Enterprise (included in the trade sector), Native Americans constitute an important part of the County economy. Government is the second-largest employment sector in Okanogan County, next to agriculture. As in most areas, local government employment in education is the largest single employer. The County also has relatively large Federal employment providing maintenance and management of irrigation systems and National Forest lands.

3.7.4 TRIBAL ECONOMIES

Although Indian Tribes are considered sovereign nations, the economies of the Columbia Basin Tribes are intricately connected to the greater Pacific Northwest economies of Washington, Oregon, and Idaho. The project area Indian Tribes engage in a variety of commercial, industrial, tourism, recreation, gaming, and natural resource activities that create jobs and personal income for Indians and non-Indians alike. In Washington State alone, the 27 Federally recognized Tribes contribute nearly \$1

billion yearly to the economy of the State (Tiller and Chase 1999).

The average annual wage for Tribes in Washington remains significantly lower than the State as a whole. For Tribal-owned enterprises in eastern Washington (Colville and Yakama Indian Tribes), the average annual wage was estimated at approximately \$16,907 (Tiller and Chase 1999), compared to year 2000 average Statewide wage of \$37,038. Provided below is more detailed information on the components of the economies of the project area Indian Tribes.

Historically, natural resources have been the mainstay of the economies of the Indian Tribes in the Columbia Basin. Hunting, fishing, and gathering are activities that have been important to Tribes for thousands of years. These activities not only continue to be important economically, but also for subsistence and ceremonial purposes. Today, the natural resource portion of the affected Tribal economies, which constitutes 8 percent of the total employment, is made up of fishing, agriculture, food processing, forestry/timber production and wood processing, livestock grazing, and power production (Table 3-16).

Fishing is the main Tribal industry that would be most affected by activities at the three project area dams. The Tribes in the area conduct both a commercial and non-commercial (subsistence and ceremonial) fish harvest. Four of the Tribes are part of the commercial fishery that occurs in the mainstem of the Columbia River between Bonneville and McNary dams (referred to as Zone 6). Known as the Columbia River Treaty Tribes, the Warm Springs, Umatilla, Yakama, and Nez Perce Indians participate in the commercial fishery for fall-run chinook salmon, summer steelhead, coho salmon, and sturgeon. In 2000, the Tribes landed 52,419 chinook salmon, 15,540 steelhead, 6,299 coho salmon, and 3,447 sturgeon during the commercial fishing season (Joint Columbia River Management Staff 2001).

 Table 3-16.
 Percent Total Employment Paid for Selected Sectors, 1997-1998

	Washington State % Total Employment	INDIAN TRIBES % TOTAL EMPLOYMENT
Agriculture, Forestry, Fishing	3.7	8.0
Manufacturing	14.4	6.0
Retail	17.8	2.0
Services	26.1	52.0 ¹
Government	17.0	29.0

¹ The majority of this percentage is casino and gaming employment (approximately 45 percent). Source: Tiller and Chase 1999.

No information is available on how the fish harvest is divided among the four Tribes. The commercial fishery represents a significant part of the economies of the four Tribes. Estimates of the Tribal salmon fishery in Washington were valued at almost \$7 million in 1997 (Tiller and Chase 1999). However, over time, there has been a substantial decline in salmon stocks, and this decline has affected the economies of the project area Tribes.

The subsistence fish harvest for the four Treaty Tribes includes the fish species listed above and also includes sockeye and spring- and summerrun chinook salmon. In 2000, the Treaty Tribes caught 14,635 fall-run, 11,250 spring-run, and 280 summer-run chinook salmon, 6,628 steelhead, 2,765 sockeye salmon, 1,884 coho salmon, and 324 sturgeon, and for subsistence or ceremonial purposes (LeFleur 2001 personal communication; Joint Columbia River Management Staff 2001).

Three of the project area Tribes have made large investments in agriculture. These include the Yakama, Umatilla, and Nez Perce Indians. Each of these has lands dedicated to irrigated cropland (the Nez Perce Indians also practice some dry land farming). For example, the Yakama Indian's Land Enterprise has been establishing fruit orchards since 1989. They have constructed a cold storage facility and are in the process of developing their own fruit-processing warehouse.

In 1999, the Yakama Indians planted approximately 1,138 acres of orchard land, primarily producing apples. Other crops produced by the Yakama Indians include cherries, peaches, nectarines, plums, pears, apricots, asparagus, sweet corn, wheat, and alfalfa (Yakama Indian Nation 2001).

Forestry is another of the resource-based industries that make up Tribal economies. All five Tribes utilize this resource to some extent, and several of the Tribes—particularly the Yakama, Colville, and Warm Springs Tribes—rely heavily on this resource. The Yakama Indian Nation manages approximately 309,000 acres of commercial timber on reservation land and has an annual sustained harvest of 143 million board feet of timber. The Yakama Forest Products Division employs 130 people. They recently dedicated ground for construction of a new \$35 million large-log sawmill that will add 150 employees (Daily Journal of Commerce 2001).

Forestry enterprises operated by the Colville Indians include Colville Tribal Logging, Colville Indian Precision Pine, Colville Timber Resource Company, and Inchelium Wood Treatment Plant. The Warm Springs Indians operate Warm Springs Forest Products. While there are no available figures for the value of the timber harvest for the five area Tribes, there is an estimate for timber harvest from all Tribal lands in Washington State. In 1997, the value of the timber harvest from

Tribal lands was approximately \$71.2 million. This industry contributes substantially in terms of wages, income, and employment for Indians and non-Indians (Tiller and Chase 1999).

While all of the project area Tribes likely use some land for grazing, the Umatilla Indians actively engage in this activity. They use grazing land for both cattle and horses and as late as the 1960s exercised grazing rights on Federal land adjacent to the reservation. The Umatilla Indians are interested in forming a livestock cooperative to exercise their grazing rights on Federal land again (Umatilla Tribes 2001).

The Warm Springs Indian Tribe is also involved in power production. The Tribe has constructed generating and power transmission facilities at Pelton Reregulating Dam and are co-licensees of the Pelton-Round Butte project. The facilities are owned and operated by the Warm Springs Power Enterprises, which sells the electrical power to PacifiCorp.

Tribal governments are another important segment of the Indian economy (see Table 3-16). Government activities may include housing, health and human services, fire protection, police,

planning, Tribal court, education, public works, economic and community development, and recreation. Aside from carrying out their traditional administrative functions, Tribes own and manage enterprises across a wide spectrum of economic activity.

As described in the land use section, one of the biggest changes to the economies of the Tribes has been the development of casinos. In 1988, the U.S. Congress passed the Indian Gaming Regulatory Act, which authorized casino gaming as a way to promote a viable economic base for Tribal government programs, economic development, and self-sufficiency. As a result, all five Tribes have developed casinos. These include the Yakama Indians' Legends Casino; the Umatilla Indians' Wildhorse Casino Resort; the Warm Springs Indians' Indian Head Gaming Center; the Nez Perce Indians' Clearwater River Casino and It'SE YE YE Casino: and the Colville Indians' Mill Bay Casino, Coulee Dam Casino, and Okanogan Bingo-Casino. The casinos have become major employers of the Native American populations on the reservations they serve. In 1997 and 1998, casinos and gaming provided approximately 23 percent of Tribal employment (see Table 3-16).

3.8 ECONOMICS

Key Terms

aMW – Average megawatts per hour for every hour in the period from March through September for this project.

First Year Value – First year value is the cost and foregone power revenues incurred in the first year of the 50-year analysis period.

Levelized Value – Constant stream of values, using a given iterest rate, that produces the same net present value as the nonconstant stream of values (if future values change over time).

Net Present Value – Discounted values today of the future values using a given discount rate.

* See Chapter 7 for a complete listing of all Key Terms.

This section describes the regional need for power and the economic costs of implementing the fish conservation measures representing existing conditions for each of the three Mid-Columbia River dams.

3.8.1 Existing Power Needs

Douglas County PUD owns the Wells Project, which has a capacity of 840 megawatts. A fixed portion of this power serves the needs of Douglas County residents, and the remaining power output is sold under long-term contracts to various utilities in the Pacific Northwest to meet their energy needs. When the PUD's share of the project output is not sufficient to meet the needs of Douglas County residents, the Douglas County PUD purchases the needed energy from other generating plants.

Chelan County PUD owns the Rocky Reach and Rock Island Projects, with power generation capacities of 1,280 megawatts and 624 megawatts, respectively. Power operations are similar to those described above for the Wells Project.

3.8.2 FUTURE LOAD PROJECTIONS

The Wells, Rocky Reach, and Rock Island Projects are part of the Northwest Power Pool subregion of the Western Electric Coordinating Council (previously known as the Western System Coordinating Council) region of the North American Electric Reliability Council. Peak summer demand of the Western Electric Coordinating Council region is expected to increase about 2.2 percent for the current 10-year planning period (2001 to 2010). The winter power demand in the Northwest Power Pool subregion is expected to increase an average of about 2.0 percent (the Northwest's peak power demand is in the winter). Energy load growth rates over this same period are expected to increase at 2.4 and 1.8 percent, for the Western Electric Coordinating Council and Northwest Power Pool, respectively.⁴

3.8.3 Power Generation and Demand Balance

The region currently has a balance of generation and demand (Western System Coordinating Council 2001). If an economic recovery occurs that results in an increased demand for energy, an imbalance of supply and demand will result in an energy shortfall. In addition to the imbalance in supply and demand, a loss of energy and capacity associated with the proposed project alternatives would impact the Northwest Power Pool transmission system during emergencies, when the generation is needed to stabilize the region's transmission system or to recover from an electrical outage. The location of these projects in relation to the Northwest Power Pool's transmission system can have a significant effect on the reliability of the transmission system. This is due to the substantial size of the projects' capacities and energy output, their location in the Northwest Power Pool's transmission system, and their location relative to the markets being served.

The impact of energy and capacity losses associated with the alternatives could be mitigated over time if new generation plants are brought on line. However, due to the volatility in the short-term energy prices within the Western Electric Coordinating Council region and the Northwest Power Pool region, plans to add more generation capacity have been either delayed or cancelled. If this trend continues, energy and capacity losses associated with the project alternatives may not be replaced, which would reduce the reliability of the transmission system in the region.

The total effect from lost energy and capacity and changes in prices depend on the number of new generating plants constructed over the next 50 years.

3.8.4 2002 Costs for Existing Conditions

Provided in Table 3-17 and illustrated in Figures F-1 through F-9 (Appendix F) are the annual costs for fish conservation measures for each of

⁴ See WSCC (Western Systems Coordinating Council), 10-Year Coordinated Plan Summary 2001-2010, August 2001. Note – WSCC is the predecessor organization to the WECC (Western Electricity Coordinating Council) created on April 18, 2002.

the three dams. Costs include measures for juvenile and adult passage, hatchery-based compensation, monitoring and evaluation, and predator control but do not include or quantify other hydropower costs and benefits not associated with these fish conservation measures. The value of voluntary spill is calculated as the replacement cost of the foregone energy and capacity.

TABLE 3-17. ANNUAL COSTS OF MITIGATION MEASURES UNDER EXISTING CONDITIONS (IN MILLIONS OF DOLLARS)

FISH PROTECTION MEASURES ¹	WELLS	ROCKY REACH	ROCK ISLAND
Passage	3.6	7.3	0
Gas Abatement	0.2	0.25	0.25
Predator Control	0.2	0.2	0.2
Hatchery Program	2.9	0.9	2.5
Spill Program	0^2	8.0	3.2
Monitoring and Evaluation	0.4	2.0	0.4

¹ Includes only baseline conditions.

3.9 AESTHETICS

3.9.1 PROJECT AREA

The project area is located within the middle reach of the Columbia River, which is the geographic center of Washington State. However, because the project is on the east side of the Cascade Mountains, it is considered to be within eastern Washington. The project setting is primarily rural (with the exception of the urbanized areas of Wenatchee and East Wenatchee). In general, the area surrounding the three dams includes rangeland, irrigated farmlands, and a mixture of private and Federally owned lands.

3.9.1.1 Wells Dam

Wells Dam is located in an agricultural valley surrounded by scenic shrub-steppe desert. The land is mostly privately owned, and is used for orchards, rangeland, and residences. Federal lands managed by the BLM are located east (a small parcel close to the dam) and west (a larger parcel located 2 miles away) of the dam. Five miles to the northwest are the forest lands of the

Okanogan National Forest. Views from the several waterfront parks in the area can be considered scenic, with the natural beauty of the Columbia River in the foreground, and the shrubsteppe hills in the background. Outside of the winter months, the intermingling of green, irrigated parcels with brown, non-irrigated parcels provides an impression of a desert and oasis. In the winter, much of the area is infrequently covered by snowfall.

3.9.1.2 Rocky Reach Dam

A broad river valley surrounds the Rocky Reach Dam, with apple orchards lining both sides of the Columbia River. Private residences, a residential subdivision, some commercial uses, and several parks are also part of the visual setting of the area. Similar to the Wells Dam vicinity, the land surrounding Rocky Reach reservoir is generally rural in character, with approximately half of the land being undeveloped shrub-steppe, grasslands, or exposed rock. The other half is developed for agriculture, recreation, and residential uses. Also similar to the Wells Dam vicinity, the several

² Included with passage program.

parks and agricultural land intermixed with the non-irrigated shrub-steppe hills provide an impression of a desert and oasis setting outside of the winter months.

The reservoir impoundment (Lake Entiat) dominates the scene in the local area, being visible from a large area (the lake extends upriver about 43 miles and has a surface area of approximately 98,000 acres). Because the river terraces are relatively level and sparse vegetation is present, there is little or no visual screening of the project and impoundment. Where slopes along the shoreline are relatively gentle, narrow bands of riparian vegetation and wetland areas exist.

Adjacent to the visitor center and powerhouse, 30 acres of lawns and gardens add to the scenery. In addition, 8,000 colorful annual flowers are planted in a new design each year. A display of bright red, white, and blue annual flowers depicts the U.S. flag, and several varieties of dahlias add to the color at the visitor center grounds.

3.9.1.3 Rock Island Dam

The aesthetics in the vicinity of Rock Island Dam differ from the aesthetics in the vicinity of Wells and Rocky Reach dams in that the Columbia River valley narrows into steep bluffs in this area. The dam creates a 21-mile reservoir covering approximately 3,300 acres, along which several parks are located; there are no visible adjacent land uses because of the steep bluffs.

3.9.2 ASSOCIATED TRIBUTARIES

The main tributaries associated with the three dams include the Wenatchee, Entiat, Methow, and Okanogan Rivers (in order from south to north). The Wenatchee and Okanogan National Forests surround most of the Wenatchee, Entiat, and Methow Rivers, while the lower portion of the Okanogan River is bordered on the east by the Colville Indian Reservation. The scenery along all four rivers and their associated creeks is predominantly rural in the lowlands and forest in the higher elevations. The scenery in the lowlands varies between narrow valley floors surrounded by mountainous terrain, with numerous apple and other fruit orchards to rolling plateaus.

3.10 RECREATION

Recreational opportunities associated with streams and rivers are important to both residents and visitors. Both directly and indirectly, waterrelated activities and settings define an important part of the area's quality of life and economy. Public and private lands on and near the project area and its tributaries are used for a wide variety of recreational activities.

The original license for the Wells Dam included by reference general terms and conditions for major projects (FERC 1953). With regard to recreation, Article 7 states: So far as is consistent with proper operation of the project, the Licensee shall allow the public free access, to a reasonable extent, to project waters and adjacent lands owned by the Licensee for the purpose of full public utilization of such lands and water for navigation and recreational purposes, including hunting and fishing, and shall allow to a reasonable extent for such purposes the construction of access roads, wharves, landings, and other facilities...

Policies on recreational use were clarified by Order No. 313, Issuing Statement of General

Policy, Recreational Development (FERC 1965). This order encourages preparation of comprehensive recreation plans for all projects. Pursuant to this and other FERC requirements, Douglas County PUD prepared public use and recreation plans for the Wells Project that are now part of the project license (FERC 1987a). Recreational facilities and improvements included in the plan are described below in Section 3.10.1, Project Area. The recreation plan is updated every 5 years.

The original license for the Rocky Reach Dam (FERC 1957a) included the same general terms and conditions regarding recreation described above for the Wells Dam. The recreation plan for the project (Exhibit R), prepared pursuant to Order No. 313 (FERC 1965) and other requirements, was approved in 1976 (FERC 1976). Since the plan's approval, Chelan County PUD has implemented the overall plan, with some small revisions submitted for FERC approval (Chelan County PUD 1991). The facilities and improvements included in the current plan are described below in Section 3.10.1, Project Area.

The original license for the Rock Island Dam (FERC 1957a) included the same general terms and conditions regarding recreation described above for the Wells Dam. Like the Rocky Reach Project, a recreation plan was prepared for the project and was approved (FERC 1989b). The plan is being implemented, with a request to expand the camping and picnicking facilities at the North Confluence Park (Chelan County PUD 1992). The facilities and improvements included in the plan are described below in Section 3.10.1, Project Area.

3.10.1 Project Area

Tourism and recreation are important to the local economies in the project area. The reservoirs formed by the three dams, as well as numerous public parks in the project area, are popular sites for recreational activities including boating,

camping, swimming, hiking, soccer, softball, and football. While some recreational fishing occurs in the reservoirs, the relatively undeveloped shorelines and littoral zones and low water retention time in the reservoirs are factors that are not conducive to a high abundance of most resident fish (BPA 1995e). In addition, Washington State Regulations prohibit or limit fishing in the mainstem Columbia River due to the recent listing of threatened and endangered species. Descriptions of existing recreational facilities in the project area are provided below, followed by a brief discussion of existing recreational fishing conditions.

3.10.1.1 Existing Recreational Facilities

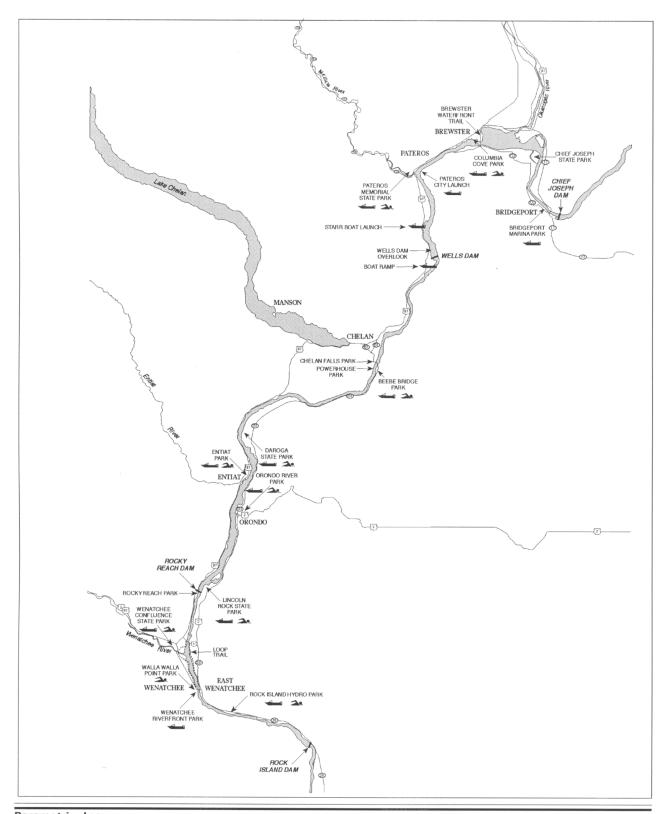
In addition to the public recreational facilities described below and shown on Figure 3-14 (listed proceeding upstream), there are many private residences along the reservoir with direct access to the water. Recreation at all sites on the river is most intensive during the summer season: Memorial Day through Labor Day. The opening of fishing season is also a period of peak activity.

Rock Island Hydro Park

Rock Island Hydro Park is located on 70 acres, 2 miles south of East Wenatchee on State Route 28. The park includes baseball/soccer fields (two with lights), picnic areas, picnic shelter, swimming, boat launch, boat trailer parking, tennis, volleyball, 1.1 miles of trail, and restrooms. In 1997, 180,913 people visited the park, while in 1998 the user numbers increased to 181,331 people. The park had the most users in July and August, with the lows occurring in October and November. The park is owned and managed by Chelan County PUD (Chelan County PUD 1999e).

Wenatchee Riverfront Park

Wenatchee Riverfront Park is located on 31 acres in downtown Wenatchee along the Rock Island



Parametrix, Inc. Mid Columbia/553-1543-020/01(10) 11/02 (K)





WATER DEPENDENT FACILITIES

Boat Ramp
Swimming Beach

Figure 3-14 Project Area Parks

reservoir. The park includes 1.1 miles of shoreline trail, special event mini-railroad, ice rink, two-lane boat launch, short-term moorage, boat trailer parking, and restrooms. The park trail connects with Walla Walla Point Park and the Wenatchee State Park to provide 5 miles of paved bicycle and pedestrian trail. This trail connects through bridges to East Wenatchee, where the Apple Capitol Recreation Loop trail follows the east bank of the reservoir. In 1997, 964,654 people visited the park. In 1998, the park had an increase to 969,804 visitors. The park was busiest between July and August, with the lowest amount of activity occurring in October and November. The park is owned and managed by Chelan County PUD (Chelan County PUD 1999e). The East Wenatchee segment of the trail is managed by the Douglas County Parks Department.

Walla Walla Point Park

Walla Walla Point Park is located on 70 acres in Wenatchee (and adjoins Wenatchee Riverfront Park). The park includes a fourplex soccer/ softball complex (each with field lights), swimming, 1.2 miles of trail, tennis, volleyball, horseshoe pits, playground equipment, restrooms, picnic shelters, and a special events area. In 1997, 635,649 people visited the park, with the majority of the use occurring during daytime as opposed to overnight park users. In 1998, the user numbers increased to 655,364 people, continuing the same trend of daytime use. The park had the most users between July and August, with the lows occurring in October and November. The park is owned and managed by Chelan County PUD (Chelan County PUD 1999e).

Wenatchee Confluence State Park

Wenatchee Confluence State Park is located on 200 acres in Wenatchee on both sides of the Wenatchee River where it joins the Columbia River. The park includes camping (59

tent/recreational vehicle sites, 51 of which have electricity, water, and sewer), baseball/soccer field, two-lane boat launch, boat trailer parking, swimming, restrooms, showers, picnic shelter, volleyball, tennis, playground equipment, Wenatchee River pedestrian bridge, 4.5 miles of trail, wildlife area, interpretive graphics, and a recreational vehicle dump station. An estimated 362,322 people visited the park in 1997, with the majority of the use occurring during daytime as opposed to overnight park users.

In 1998, the park had an increase to 485,266 people, continuing the same trend of daytime use. The significant increase in visitors from 1997 to 1998 is primarily due to the flooding that occurred in 1997 that inhibited many visitors from using the park's facilities. The park saw the most visitors between July and August, with very low activity occurring in October and November. The park is owned by Chelan County PUD (Chelan County PUD 1999e) and leased to the Washington State Parks and Recreation Commission.

Rocky Reach Dam

Rocky Reach Dam and visitor facilities are located on 38 acres, 6 miles north of Wenatchee on State Route 97A. The visitor facilities include extensive landscaping, 20 picnic areas, 2 picnic shelters, playground equipment, 2 horseshoe pits, visitor center, fish viewing room, historical galleries, 3 restrooms, and 241 parking spaces. In 1998, 276,488 people visited the park, while in 1999 the user numbers increased to 289,827. Most people visit the park between Memorial Day and August, with very little activity from September through April. The facilities are owned and managed by Chelan County PUD (Chelan County PUD 1999e).

In support of the relicensing process for the Rocky Reach hydroelectric project, the Chelan County PUD recently completed a detailed recreation study, which included a recreation resources inventory, a recreation needs forecast and analysis, and a recreational use assessment. The 1999/2000 Recreational Use Assessment Study Report (Howe Consulting, Inc. and Duke Engineering & Services, Inc. 2001a) assessed recreation occurring at existing developed recreation sites and dispersed uses within the Rocky Reach Project boundary (from Rocky Reach Dam to Wells Dam). The Recreation Resources Inventory Summary Report (Howe Consulting, Inc. and Duke Engineering & Services, Inc. 2001b) assessed developed and undeveloped recreational sites located on public and private lands; mitigation lands; lands owned and/or managed by Federal, State, and local agencies; and lands owned by non-government organizations. The inventory also assessed the adequacy of access to the project reservoir from adjacent lands. The Recreation Needs Forecast and Analysis (Howe Consulting, Inc. and Duke Engineering & Services, Inc., 2001c) assessed the recreation needs in the Rocky Reach Project area.

Lincoln Rock State Park

Lincoln Rock State Park is located on 65 acres, 7 miles north of East Wenatchee on State Route 2. The park includes camping (94 tent/recreational vehicle sites: 35 with electricity and water; 32 with electricity, water, and sewer; and 27 standard), a baseball field, a three-lane boat launch, 6 tie-up docks, 102 boat trailer parking spaces, short-term moorage, swimming, 6 restrooms (44 toilets, 12 showers), 166 picnic tables, 3 picnic shelters, playground equipment, an open court area, 2 volleyball courts, 2 tennis courts, 3 horseshoe pits, amphitheater, concession building, recreational vehicle dump station, and 148 day-use parking spaces.

In 1998, 256,508 people visited the park, with the majority of the use occurring during daytime as opposed to overnight. In 1999, the user numbers decreased to 232,181 people, but still continued the same trend of daytime use. The decrease in visitors from 1998 to 1999 can be attributed to charges that began in 1998 for daytime park users

and also an increase in camping fees. The park has the most users between Memorial Day and August, with lows occurring from September through April. The park is owned by Chelan County PUD (Chelan County PUD 1999e) and is leased to the Washington State Parks and Recreation Commission.

Turtle Rock Island

Turtle Rock Island is a 160-acre island located approximately 2 miles upstream from the Rocky Reach Dam. A small (less than 1 acre) sandy beach attracts boat-in visitors to the island. While no recreational facilities are located on the island, boat-in visitors use the beach for swimming and relaxing. Given the small size of the beach area, use is limited by the number of boats (approximately four to five) that the beach can accommodate at one time. The island possesses wildlife habitat value, and a Washington State fish hatchery is located on the island. The site is owned by Chelan County PUD (Chelan County PUD 1999e).

Orondo River Park

Orondo River Park is located on 5 acres on the east side of Rocky Reach reservoir, approximately 2 miles north of Orondo. The park includes 14 recreational vehicle sites (10 with electricity and water), 10 to 15 tent sites, 1 restroom (4 toilets, 4 showers), swimming, a volleyball court, a one-lane boat launch, 3 tie-up docks, 14 boat trailer parking spaces, short-term and overnight moorage, 14 picnic tables, a picnic shelter, concessions, a horseshoe pit, JetSki rentals and marine gas, and 22 day-use parking spaces. A total of 36,824 people visited the park in 1998, with the majority of the use occurring during daytime as opposed to overnight. In 1999, visitor numbers increased to 43,278, continuing the same trend of daytime use. Memorial weekend through August were the busiest times for visitors, while September through April were the months that had the least number of visitors.

The park is managed by the Port of Douglas County.

Daroga State Park

Daroga State Park is located on 140 acres on the east shore of Rocky Reach, 8 miles north of Orondo. The park offers camping (28 tent/recreational vehicle sites with electricity and water, 17 walk-in or boat-in sites, and 2 group camping areas), a baseball field, a soccer field, 2 basketball courts, an open court area, tennis courts, a two-lane boat launch, boat trailer parking, playground equipment, a combination tennis and basketball court, short-term moorage, swimming, 4 restrooms (38 toilets, 12 showers), 3 picnic shelters, a 2.5-mile shoreline trail, and a recreational vehicle dump station. In 1998, 137,360 people visited the park, with the majority of the use occurring during daytime as opposed to overnight camping. In 1999, visitors increased to 164,611 people, continuing the same trend of daytime use. The park had the most users between Memorial weekend and August, with the lows occurring between September and April. The park is owned by Chelan County PUD (Chelan County PUD 1999e) and is leased to the Washington State Parks and Recreation Commission.

Entiat Park

Entiat Park is located on 40 acres on the west side of Rocky Reach reservoir in Entiat. The park includes camping (50 tent sites and 31 recreational vehicle sites with complete hookups), boat launch, boat trailer parking, swimming, 3 restrooms (12 toilets, 4 showers), recreational vehicle dump station, playground equipment, 108 picnic tables, 1 picnic shelter, a volleyball court, 2 horseshoe pits, and 43 day-use parking spaces. In 1998, 150,278 people visited the park. The majority of the park was used for daytime activities rather than camping. In 1999, use decreased to 84,390 people, continuing the same trend of daytime use. The significant decrease from 1998 to 1999 can be attributed to 'counting

device' construction changes that occurred near the entrance to the park. A new counter was installed in 1999, replacing an inadequate and often inaccurate counting device. The park had the most users between Memorial weekend and August, with the lows occurring from September through April. The park is managed by the City of Entiat Parks and Recreation Department.

Beebe Bridge Park

Beebe Bridge Park is located on 56 acres on the east shore of Rocky Reach reservoir, 21 miles north of Orondo on State Route 97. The park offers camping (46 tent/recreational vehicle sites with electricity and water), 3 restrooms (24 toilets, 6 showers), 196 day-use parking spaces, 14 picnic tables plus 14 more in a picnic shelter, a swimming area, a two-lane boat launch, shortterm boat moorage, 2 tennis courts, playground equipment, a baseball field, a soccer field, a volleyball court, an open court area, a shoreline trail, and a recreational vehicle dump station. In 1998, 109,923 people visited the park, with the majority of the use occurring during daytime as opposed to overnight. In 1999, there was a decrease to 97,346 visitors, the majority of the visitors using the park for daytime activities. The park had the most users between Memorial weekend and August, with the lows occurring from September through April. The park is managed by Chelan County PUD (Chelan County PUD 1999e).

Wells Dam Overlook

The Wells Dam Overlook is a tree-filled park overlooking the Columbia River and Wells Dam. The park includes a turbine runner from Wells Dam on display, an interpretive area, a petroglyph display, picnic shelter, and restrooms. No use estimates are available. The park is managed by Douglas County PUD. Boat launch facilities are provided below Wells Dam and to the north of the dam off of Highway 97.

Pateros Memorial Park

Pateros Memorial Park is located in the town of Pateros at the confluence of the Methow and Columbia Rivers on the Wells reservoir. The park includes a paved pedestrian walkway along the riverfront, picnic shelters, boat launches, fishing and ski docks, and restrooms.

Pateros City Boat Launch

Also in Pateros is a boat launch located at the upstream end of Memorial Park. This boat launch is open all year round and contains a dock and parking sites. This launch is also managed by the city of Pateros.

Peninsula Park

Also in Pateros, Peninsula Park on the Methow has a swimming area, picnic shelter, restrooms and play area. No use estimates are available for this park. The park is managed by the City of Pateros. A boat launch facility with toilets is provided on the Methow River just above Pateros and off of State Route 153.

Columbia Cove Park

Columbia Cove Park is located in Brewster and is a day-use area complete with a sandy beach and swimming area, picnic shelters, boat launch and dock facilities, basketball court, play area, and restrooms. It is located adjacent to ball fields and the city swimming pool. No use estimates are available. The park is managed by the City of Brewster.

Brewster Waterfront Trail

The Brewster Waterfront Trail is a ½-mile graveled pedestrian walkway along the Wells reservoir adjacent to the downtown area. The park includes picnic areas and benches. The park is accessible at several locations. No use estimates are available. The park is managed by

the City of Brewster. Boat launch facilities, with public toilet, are also provided on the Okanogan River, upstream of Monse.

Chief Joseph State Park

This park is located on an island on the south shore of Wells reservoir, west of Bridgeport. The park is largely undeveloped, with a simple boat launch. No motor vehicles are allowed on the island. No estimates of use are available for the park. The park is managed by the Washington State Parks and Recreation Commission.

Bridgeport Marina Park

The Bridgeport Marina Park is located adjacent to the Wells reservoir in Bridgeport. The park includes 18 full hookup recreational vehicle sites, 2 tent pads, restrooms, a playground, beach and swimming area, boat docks, 2 boat launches, picnic shelters, and a gazebo. In 1997, 69,108 people visited the park, with the majority of the use occurring during daytime as opposed to overnight. In 1998, the user numbers increased to 74,131 people, continuing the same trend of daytime use. The park had the most users between July and August, with the lows occurring in October and November. The park is managed by the City of Bridgeport.

3.10.1.2 Recreational Fishing

Washington State Fishing Regulations for 2002 indicate that recreational fishing within the project area is open year-round for game fish other than trout (smallmouth bass, walleye), and is operated as catch and release only for sturgeon all year. In addition, fishing is open to summer/fall-run chinook salmon due to the strong return of these fish in 2002. Fishing for trout in the project area at all three dams is closed at all times, as is fishing between the upstream line of each dam to boundary markers 400 feet downstream of the fishladders at Rocky Reach and Rock Island dams, and 400 feet downstream of the spawning channel discharge (on the Chelan

County side) and the fishladder (on the Douglas County side) at Wells Dam. Fishing for springrun chinook, steelhead, and bull trout is closed due to their Federal listing status. However, when numbers of hatchery returning fish exceed escapement goals, there are provisions for a limited steelhead fishery in the Okanogan and mainstem Columbia Rivers.

In addition to the game fish species mentioned above, over 20 other species (such as northern pikeminnow, whitefish, northern squawfish, and pumpkinseed) may be taken by anglers while fishing in the project area. However, in a dissolved gas monitoring survey conducted by Dell et al. (1975), resident game fish accounted for less than 2 percent of the total of 32,289 fish sampled. A description of the resident fish expected to occur in the project area is included in Section 3.2.8, Species of Concern, along with brief life-history descriptions.

Angling activity specific to the Rocky Reach reservoir was documented in the 1999/2000 Recreational Use Assessment Study Report (Howe Consulting, Inc. and Duke Engineering & Services, Inc. 2001a) prepared as part of the relicensing process for the Rocky Reach Dam. Boat runs, car runs, and on-site interviews were conducted during mid-day and early afternoons, and creel surveys were conducted in the early morning and late afternoon/early evening.

In summary, relatively few anglers were observed in Rocky Reach reservoir or along undeveloped shorelines. During the peak season, an average of less than two people per day were observed shore angling at public recreation sites, with most of the people observed during weekday observations. During peak-season boat runs, people in about 5 percent of the boats were observed angling. An average of approximately 1.5 boats per weekday and an average of 6 boats per weekend day were observed being used for angling. During fall season boat runs, approximately 40 percent of the boats observed were used for angling. An average of almost five anglers per day were observed along undeveloped shorelines during peak-season weekends. No anglers were

observed along undeveloped shorelines during weekday boat runs. The most angling activity that was observed during monitoring efforts was during late summer, when summer/fall-run chinook salmon fishing was open on the Columbia River (opened August 10 and closed October 21, 2000).

3.10.2 ASSOCIATED TRIBUTARIES

3.10.2.1 Existing Recreational Opportunities

The four tributary rivers (Okanogan, Methow, Entiat, and Wenatchee) are popular for a variety of recreational activities. Active recreation on these rivers includes kayaking, rafting (private and commercial), other boating, fishing, and swimming. The rivers are indirectly related to camping, hiking, bird watching, and similar outdoor activities that benefit from a waterfront setting.

The Interagency Committee for Outdoor Recreation (IAC) has Statewide responsibility for assisting local, State, and Federal agencies in planning, acquiring, and developing recreational resources. In 1990, the IAC published detailed profiles of each county, including an inventory of recreational facilities by type of provider. Summaries of the profiles for the three counties within the project area (Chelan, Douglas, and Okanogan counties) are shown in Tables 3-18, 3-19, and 3-20. The IAC updated this inventory in 1995, but the updated version does not categorize the data by county, thus the 1990 data remains the most current information available.

Chelan County includes large areas of Federally managed lands used for recreation and other purposes. These include the Wenatchee National Forest, North Cascades National Park, Lake Chelan National Recreation Area, and several wilderness areas. The county has trails for hiking, horseback riding, and off-road vehicle riding. The Wenatchee River is popular for recreation. Fishing is currently closed except for

TABLE 3-18. RECREATIONAL FACILITIES IN CHELAN COUNTY BY TYPE OF PROVIDER, 1990

	Local	STATE	FEDERAL	PRIVATE	TOTAL ¹	
General						
Number of Sites	51	15	84	32	182	
Developed Acres	527	42,049	838	4,959	48,373	
Shoreline (feet)	26,464	124,576	196,390	14,390	361,820	
Boating						
Moorage Slips	36	85	140	470	731	
Moorage Buoys	0	4	0	26	30	
Launch Lanes	6	8	0	6	20	
Trailer Parking	110	313	35	348	806	
Camping/Day Use						
Total Camp Units	402	454	764	874	2,494	
Units with Hookups	201	31	0	671	903	
Day Picnic Tables	363	128	65	ns ²	556	
Day Picnic Shelters	14	4	8	ns ²	26	
Swimming						
Indoor Pools	1	0	0	03	1	
Outdoor Pools	4	0	0	6 ³	10	
Swimming Beach (feet)	2,368	786	0	380	3,534	
Sports						
Baseball/Softball Fields	52	0	0	ns ²	52	
Football/Soccer Fields	22	0	0	ns ²	22	
Tennis Courts	35	0	0	14	49	
Other Courts	35	0	0	ns ²	35	
Trail Miles						
Hike	0	25	1,414	ns ²	1,439	
Horse	0	5	1,301	ns ²	1,306	
Recreational Vehicle/Motorcycle	0	0	370	ns ²	370	

Source: Interagency Committee for Outdoor Recreation (1990)

More recent countywide date is not available.
 ns = not surveyed
 Private sector data reflects sites with pools only, not total number of pools.

RECREATIONAL FACILITIES IN DOUGLAS COUNTY BY TYPE OF PROVIDER, 1990 **TABLE 3-19.**

	LOCAL	STATE	FEDERAL	PRIVATE	TOTAL ¹
General					
Number of Sites	31	6	1	7	45
Developed Acres	247	3,067	58	73	3,455
Shoreline (feet)	1,650	32,800	21,120	8,720	64,290
Boating					
Moorage Slips	15	66	0	0	81
Moorage Buoys	0	0	0	0	0
Launch Lanes	3	7	1	4	15
Trailer Parking	120	640	30	3,512	4,302
Camping/Day Use					
Total Camp Units	33	96	0	285	414
Units with Hookups	12	67	0	165	244
Day Picnic Tables	135	60	6	ns ²	201
Day Picnic Shelters	10	3	0	ns ²	13
Swimming					
Indoor Pools	1	0	0	0^3	1
Outdoor Pools	3	0	0	1 ³	4
Swimming Beach (feet)	0	180	0	0	180
Sports					
Baseball/Softball Fields	14	0	0	ns ²	14
Football/Soccer Fields	7	0	0	ns ²	7
Tennis Courts	17	0	0	0	17
Other Courts	5	0	0	ns ²	5
Trail Miles					
Hike	0	0	0	ns ²	0
Horse	0	0	0	ns ²	0
Recreational Vehicle/Motorcycle	0	0	0	ns ²	0

Source: Interagency Committee for Outdoor Recreation, 1990

More recent countywide date is not available.
 ns = not surveyed
 Private sector data reflects sites with pools only, not total number of pools.

TABLE 3-20. RECREATIONAL FACILITIES IN OKANOGAN COUNTY BY TYPE OF PROVIDER, 1990

	LOCAL	STATE	FEDERAL	PRIVATE	TOTAL ¹
General					
Number of Sites	76	47	68	33	224
Developed Acres	1,053	47,724	525	3,048	52,350
Shoreline (feet)	54,970	182,797	199,865	50,525	488,157
Boating					
Moorage Slips	0	41	0	38	79
Moorage Buoys	0	0	0	0	0
Launch Lanes	26	35	11	8	80
Trailer Parking	108	1,110	53	94	1,365
Camping/Day Use					
Total Camp Units	247	640	1,662	1,271	3,820
Units with Hookups	72	103	0	740	915
Day Picnic Tables	230	221	96	ns ²	547
Day Picnic Shelters	22	9	2	ns ²	33
Swimming					
Indoor Pools	0	0	0	0^3	0
Outdoor Pools	7	0	0	9 ³	16
Swimming Beach (feet)	1,890	1,987	0	500	4,377
Sports					
Baseball/Softball Fields	34	0	0	ns ²	34
Football/Soccer Fields	10	0	0	ns ²	10
Tennis Courts	28	0	0	7	35
Other Courts	9	0	0	ns ²	9
Trail Miles					
Hike	0	0	1,349	ns ²	1,349
Horse	0	0	1,302	ns ²	1,302
Recreational Vehicle/Motorcycle	0	0	270	ns ²	270

¹ More recent countywide date is not available.

Source: Interagency Committee for Outdoor Recreation, 1990

whitefish in the winter. Kayaking and commercial whitewater rafting are popular from Leavenworth downstream. Lake Wenatchee and Wenatchee State Park are popular locations for swimming and boating. Both public (USFS) and private campgrounds are located along the entire river. Also in Chelan County, the Entiat River provides a setting for several USFS campgrounds. A listing of the 1990 recreational facilities in Chelan County is provided in Table 3-18 (more recent countywide data on both public and private facilities are not available).

In contrast to Chelan and Okanogan counties, Douglas County does not have large areas of land under public ownership. Most camping facilities, especially those with hookups, are provided by the private sector. There are few sporting facilities (see Table 3-19). Most of the camping and day use facilities are provided by the private sector. As would be expected from the low amount of recreational facilities available, travel and recreation have a relatively small impact on the local economy in Douglas County.

² ns = not surveyed

³ Private sector data reflects sites with pools only, not total number of pools.

Similar to Chelan County, Okanogan County has large areas of Federally managed lands used for recreation and other purposes. These include Okanogan and Colville National Forests and Pasayten and Lake Chelan-Sawtooth wilderness areas. Travel and recreation have a large effect on the county economy (see Table 3-20). On the Methow River and below Mazama, most recreational sites are privately operated. Above Mazama, the USFS provides camping and access. The river is used for fishing, rafting, and

kayaking. The Okanogan River provides fishing and boating. Most camping facilities on the river are privately operated.

Tourists expend more dollars on hotels in Chelan County, while campground spending is greatest in Okanogan County (Table 3-21). Because of the increased number of hotels in the Wenatchee area, greater tourist employment opportunities occur in Chelan County, with a corresponding increase in income from local and State taxes.

TABLE 3-21. ESTIMATED TRAVEL IMPACTS BY COUNTY, 1997

	CHELAN	Douglas	OKANOGAN
Campground Spending (\$000)	31,810	1,670	32,940
Hotel, Motel, B&B Spending (\$000)	112,110	6,400	32,410
Travel-generated Payroll (\$000)	39,680	4,040	18,340
Travel-generated Employment (# jobs)	3,650	380	1,690
Local and State Taxes (\$000)	14,550	1,710	7,190

Source: Dean Runyan Associates (1998)

3.10.2.2 Recreational Fishing

Washington State Fishing Regulations for 2002 indicate that some recreational fishing occurs in the four tributaries to the project area. However, the entire area is generally closed to salmon and steelhead fishing.

The Entiat River, from its mouth to Entiat Falls, is open for whitefish only from December 1 through March 31. The rest of the year, this section of the Entiat River is closed to recreational fishing.

The Methow River, from its mouth to Gold Creek and from Weeman Bridge to the falls above Brush Creek, is open for whitefish only from December 1 through March 31. The rest of the year, these sections of the Methow River are closed to recreational fishing. The Methow River from Gold Creek to Weeman Bridge (8 miles upstream from Winthrop) is open (catch and release) for all game fish from June 1 through

September 30, and for whitefish only from December 1 through March 31. The Twisp and Chewuch Rivers are open to catch and release trout fishing while the Lost River is open to limited retention fisheries for bull trout, rainbow trout, and cutthroat trout. The Methow River tributaries that are not listed in special rules are open June 1 through October 31 for all game fish, but closed to salmon and steelhead.

The Okanogan River, from its mouth to the highway bridge at Malott, is open year-round for all game fish other than trout, salmon, and steelhead. Upstream of the highway bridge at Malott, the Okanogan River is open to fishing for the same species from June 1 through August 31. The Okanogan River is closed to fishing for salmon, steelhead, and resident trout at all times although it was open for chinook salmon fishing in 2002, and steelhead fishing in 2001.

The Wenatchee River, from its mouth to Lake Wenatchee, is currently closed to all fishing.

3.11 CULTURAL RESOURCES

Key Terms

Character Defining Features – The components of an historic property that contribute to its historical significance.

Cultural Resource – Nonrenewable evidence of human occupations or activity as seen in any district, site, building, structure, artifact, ruin, object, work of art, architecture, or natural feature associated with the cultural practices or beliefs of a living community.

Historic Integrity – The extent to which a property has retained its original design and setting.

Historic Property – A property listed on the National Register of Historic Places.

National Register of Historic Places – The official Federal list of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, engineering, and culture.

Section 106 of the Historic Preservation Act – A Federal regulation that requires properties with Federal involvement to take into consideration impacts to properties listed in or eligible for the National Register.

* See Chapter 7 for a complete listing of all Key Terms.

The cultural resource properties in the project area include archaeological sites, historical sites, and traditional cultural properties. These properties are defined as a location associated with a "community's historically rooted beliefs, customs, and practices," which may include geographic places and natural resources. Congress developed Section 106 of the National Historic Preservation Act to avoid unnecessary harm to historic properties. Section 106 applies to "properties already listed in the National Register, properties determined eligible for listing, and properties not formally determined eligible but that meet specified eligibility criteria."

Assessment of National Register of Historic Places eligibility entails evaluation of cultural properties identified under a set of criteria specified in 36 CFR 60.4:

The quality of significance in American history, architecture, archaeology, and culture

- that are associated with events that have made a significant contribution to the broad patterns of our history; or
- that are associated with the lives of persons significant in our past; or
- that embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
- that have yielded, or may be likely to yield, information important in prehistory or history.

3.11.1 PREHISTORIC ARCHAEOLOGY

Archaeologists generally agree that a five-phase system represents a simplified prehistory of the Columbia Plateau region, which includes the Rock Island and Rocky Reach dam areas and the areas surrounding the tributaries that flow into the

is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, material, workmanship, feeling, and association, and:

⁵ National Register Bulletin 38, Guidelines for Evaluating and Documenting Traditional Cultural Properties, p. 1.

⁶ Advisory Council on Historic Preservation workbook, Section 106, Step-by-Step.

Columbia River near these dams. The prehistory of the Wells Dam area follows a similar, but distinct, chronological sequence that is described later in this section. The Columbia Plateau phases (Clovis, Windust, Vantage, Frenchman Springs, and Cayuse) each represent a time period possessing distinct settlement and/or subsistence patterns. Researchers have interpreted differences between the phases to represent changes in subsistence and settlement systems, or adaptational shifts. Table 3-22 presents a prehistoric sequence for the Columbia Plateau, defining the periods in terms of archaeological characteristics and chronological sequence.

Table 3-23 presents the chronological sequence for the lower Okanogan valley region, which includes the Wells Dam area. The tables show the phases, from top to bottom, from the most recent to the oldest defined for the region. This arrangement mirrors an archaeological stratigraphic profile, with the youngest materials, deposited most recently, nearest the top. The paragraphs following these tables, which expand on the information presented in them, are presented in chronological order: from oldest to most recent.

Although it is uncertain when people first arrived in the area, the occasional discovery of Clovis projectile points suggests a minimum date somewhere between 12,000 and 11,000 years Before Present (BP). The Clovis point, a large, bifacially flaked point with a large "flute" or flake scar at the base, is the most diagnostic artifact type of this period (Chatters 1989; Galm et al. 1987; Hollenbeck and Carter 1986; Lothson et al. 1982). In Washington to date, there have been no extensive analyses published on these early materials. The cache of approximately 14 Clovis points discovered near Wenatchee yield proxy tephra dates of post-11,250 BP (Mehringer 1989). Consequently, the characteristics of settlement and subsistence during this period are purely conjectural. Based on evidence from elsewhere in the United States, however, archaeologists believe that Clovis-age settlement consisted of

small, highly mobile bands of hunter-gatherers. Although many researchers cite Clovis points as evidence for big-game hunting, it is possible that these early inhabitants of the region had a more generalized adaptation, based on the wide distribution of these points in varied environments.

By 10,500 years BP, small, highly mobile bands populated the developing grasslands using a generalized subsistence strategy that was seasonally structured around a complex resource base. Similarly, technological innovations allowed for more intensive use of certain seasonal resources. The most diagnostic artifact is a large, stemmed or lanceolate projectile point. Other stone artifacts include bifacially flaked knives, wide, flat endscrapers, gravers, burins, bola stones, grooved net sinkers, milling stones, choppers, and simple flake tools. Bone tools include wedges, single-piece and composite harpoons, foreshafts, atlatl spurs, awls, and needles. Sparse scatters of artifacts covering areas no greater than a few hundred square meters suggest small group size and high mobility. Habitation sites included rockshelters, caves, and open areas that were frequently reused over long periods of time (Chatters 1989; Galm et al. 1987; Hollenbeck and Carter 1986; Lothson et al. 1982).

Riverine sites adjacent to rapids contain an abundance of fish remains and associated artifacts, such as grooved net sinkers and gorges. This evidence indicates increasing intensification of anadromous fish populations in the Columbia and its tributaries. In drier, upland sites, a predominance of milling stones suggests that seed gathering was also an important aspect of subsistence. The diverse composition of faunal and floral remains indicates that subsistence, while still generalized, was increasingly structured by seasonally abundant or available resources (Chatters 1989; Galm et al. 1987; Hollenbeck and Carter 1986; Lothson et al. 1982).

TABLE 3-22. COLUMBIA PLATEAU CHRONOLOGICAL SEQUENCE

YEARS BP ¹	DESCRIPTION OF	CULTURE HISTORICAL PHASES
150-present	Historic Period	Historic Period. Euroamericans settle in region.
250-150	Late Prehistoric Period	Ethnographic Period. Introduction of Euroamerican technology and non-indigenous diseases lead to culture change and significant population collapse for Native American groups.
2500-250		Cayuse Phase. Population concentrated in large, nucleated winter villages of 50+ housepits. People dispersed to gather roots in the spring and to hunt in the fall and winter. This seasonal round became increasingly diverse and well organized over time. Trade with coastal groups was common. The phase includes contracting-stemmed projectile points and triangular basal or corner-notched projectile point types.
4500-2500	Middle Prehistoric Period	Frenchman Springs Phase. Introduction of semi-subterranean houses and more specialized camps for hunting, root collecting, and plant processing. Several styles of contracting-stemmed points predominate. Many have argued that the ethnographically observed "Plateau Culture" had emerged by the end of the phase. Diagnostic projectile points include leaf-shaped points, broad-stemmed points with rounded shoulders, and triangular points with concave, expanding bases.
8000-4500	Early	Vantage Phase. Inhabitants were highly mobile, opportunistic foragers adapted mainly to riverine environments. Increasing reliance on fish with less use of game. Sites are located along stream margins and points are similar to those of the Windust Phase. Leaf-shaped (Cascade) and large (Cold Spring) side-notched projectile point types used, likely as atlatl tips.
10,500-8000	Prehistoric Period	Windust Phase. Characterized by small, highly mobile bands of foragers/collectors who exploited plant and animal resources using a seasonal settlement system. Sites are generally small and exhibit low artifact densities. Diagnostic of the phase are large, shouldered or basal notched lanceolate projectile points.
12,000-10,500		Clovis. Characterized by small, highly mobile bands of hunter/gatherers that exploited a wide range of subsistence resources, including bison and elk. Sites are usually small, exhibit low artifact densities, and are associated with older landforms, especially upland plateaus. Large lanceolate, fluted projectile points (Clovis points) are diagnostic.

¹ Before Present Source: Chatters (1989); Galm et al. (1987); Lothson et al. (1982)

TABLE 3-23. CHRONOLOGICAL SEQUENCE FOR THE LOWER OKANOGAN VALLEY REGION

YEARS BP ¹	DESCRIPTION OF CULTURE HISTORICAL PLACES
c. 1,000 - present	Cassimer Bar. Introduction of Euroamerican technology and non-indigenous diseases lead to culture change and significant population collapse for Native American groups. Increase in seasonal mobility and a shift to portable mat houses. People dispersed to gather roots in the spring and to hunt in the fall and winter. This seasonal round became increasingly diverse and well organized over time. Trade with coastal groups was common. The phase includes smaller triangular square shouldered with low corner notches and triangular basal-notched projectile point types (Columbia Corner Notched, Columbia Stemmed).
c.3,000-c.1,000	Chiliwist. More specialized camps for hunting, fishing, root collecting, and plant processing. Several styles of contracting-stemmed points predominate. Change from small dispersed winter pithouse habitation to aggregation into winter villages during this phase. Diagnostic projectile points include triangular slightly shouldered contracting-stemmed points, and triangular points with square shoulders and straight to slightly contracting stems (Nespelem Bar, Rabbit Island Stemmed).
c.4,700-c.3,000	Indian Dan. Introduction of semi-subterranean houses. Inhabitants were highly mobile, opportunistic foragers adapted mainly to riverine environments. Increasing reliance on fish with less use of game. Camps and single pithouses are located along stream margins on upper terraces. Projectile points are large, shouldered or unnotched lanceolates (Mahkin Shouldered, Cascade).
8,000-c.4,700	Okanogan. Characterized by small, highly mobile bands of foragers/collectors who exploited plant and animal resources using a seasonal settlement system. Sites are generally small and exhibit low artifact densities. Diagnostic of the phase are large basal notched lanceolate projectile (Cascade) points.
11,000-8,000	Clovis. Characterized by small, highly mobile bands of hunter/gatherers that exploited a wide range of subsistence resources, including bison and elk. Sites are usually small, exhibit low artifact densities, and are associated with early landforms, especially upland plateaus. Large lanceolate, fluted projectile points (Clovis points) are diagnostic.

¹ Before Present

Source: Chatters (1986); Grabert (1968a); Hollenbeck and Carter (1986)

Between 8,000 and 4,500 years BP, inhabitants of the region restricted their range to riverine areas, with some use of upland montane environments. With a gradual warming of the climate, regions became drier and subsistence activities became progressively less variable across the seasons. Inhabitants were probably organized as highly mobile, opportunistic foragers adapted mainly to riverine environments. Graves containing beads of olivella shells indicate that trade took place, at least indirectly, between the Pacific coast and the Columbia River Basin.

Sites and isolated projectile points dating to this period are located within river basins and at the confluence of major rivers. Faunal assemblages at these sites indicate that opportunistic hunting was restricted to a narrow range of vertebrate species. Among these species, deer and rabbit predominate followed by coyote and birds. Aquatic species, however, are found in much greater frequencies than terrestrial species, suggesting an increased focus on riverine resources as the climate warmed. Overall, the remains of freshwater mussels predominate, followed by salmon, sturgeon, or trout remains (Chatters 1989; Galm et al. 1987; Hollenbeck and Carter 1986; Lothson et al. 1982).

Between 4700 and 4500 years BP, an increase in precipitation in the region significantly altered the nature and distribution of land use during this period. Non-riverine environments gradually became more productive, leading to more diversely structured micro-environments affecting local adaptations. In addition to open sites and

rockshelters, riverine and some non-riverine environments contain pithouses. Some inhabitants were probably sedentary foragers living in widely dispersed pithouses, strategically located in game wintering areas, while others, especially along the Mid-Columbia River, maintained a mobile, opportunistic foraging adaptation. Except for a hiatus between 3800 and 3400 years BP, pithouses become more frequent throughout the period.

Toward the end of the period, non-pithouse sites are believed to reflect functionally distinct habitations including hunting camps, shell-fish processing camps, fishing camps, and plant-processing camps. Inhabitants of the region structured mobility around the availability of annual resources. Along with evidence of an increase in the use of seasonally available resources, archaeologists noted an increase in the evidence of food storage technology. Storage pits found in pithouse and rockshelter floors often contain the remains of salmon, deer, roots, and fresh-water mussels (Chatters 1989; Galm et al. 1987; Hollenbeck and Carter 1986; Lothson et al. 1982).

A return to drier conditions by 2300 to 2200 years BP affected the nature and distribution of land use. As resource productivity and diversity decreased, resources became concentrated into fewer productive patches. Archaeological evidence indicates:

- intensification of resource collection within these more patchy micro-environments; and
- an increase in travel time between resources.

Researchers have noted the wide distribution of villages of 10 to 200 pithouses on the middle and Upper Columbia River. Common artifacts of this period include narrow contracting-stemmed projectile points and triangular basal- or cornernotched points, stone bowls, elongated pestles, self-handled mauls, nephrite adze blades, tubular stone pipes, beads of clam, olivella, and dentalium shell, pendants of abalone shell, and

anthropomorphic and zoomorphic rock carvings. In the winter, people inhabited pithouse clusters, often in defensible locations. In the spring, they dispersed into small foraging groups inhabiting temporary root camps or fishing camps. Fishing was a mainstay in the summer and fall months. People stored fish, large game, and root crops for consumption during the winter months when small groups aggregated into large villages (Chatters 1989; Galm et al. 1987; Hollenbeck and Carter 1986; Lothson et al. 1982).

3.11.1.1 Wells Dam Area

G.F. Grabert (1968a) conducted salvage excavations in the Wells reservoir in the late 1960s. He noted that sites occur along much of the shoreline, with the exception of the right bank between Brewster and the mouth of the Okanogan River and the left bank between Brewster and Bridgeport. The majority of the recorded sites are small procurement camps, although pithouse villages occur near the mouth of the Okanogan River (Grabert 1968a).

Salvage excavations conducted by Chatters in the reservoir area during the early 1980s further refined Grabert's cultural phases, as shown in Table 3-18 (Chatters 1986; Grabert 1968a). Chatters excavated 13 sites with 28 structures situated on two terraces just above the reservoir. These sites yielded radiocarbon dates ranging between 360 and 7,730 BP, which indicated that large pithouses appeared after 4,040 BP (Chatters 1986).

Prehistoric use of the environments in the Wells Dam area could have resulted in sites similar to those described for the Rock Island and Rocky Reach dams.

3.11.1.2 Rocky Reach Dam Area

During the late 1950s, Washington State University surveyed the inundation area for the proposed Rocky Reach Dam reservoir and selected several sites for salvage excavation. These early investigations recorded pithouses, hunting/fishing/gathering camps, and river mussel shell middens (Gunkel 1961).

In 1983, Washington State University updated these studies and corroborated an earlier conclusion: the Rocky Reach reservoir area lacks village sites, which characterize moderately large population aggregations along the Columbia River up- and downstream from this area. Although radiocarbon dates ranging from 8,200 to 1,000 BP suggest long-term use of the area, the scarcity of village locations is problematic. The researchers also note that this stretch of the river does not have easily accessible fisheries locations such as rapids, falls, and tributary mouths, but its steep canyon walls offer prime habitat for deer, elk, and bighorn sheep; a rock alignment, which is adjacent to river margin terrace, may have been used as a hunting blind or drive line for these animals. Schalk and Mierendorf note that the Rocky Reach area may have supported temporary hunting camps for groups that resided outside of the area, or that people who adapted to a highly mobile hunting strategy lived in the narrow valley for most of the year (Schalk and Mierendorf 1983).

As part of a proposed pool elevation raise, Chelan County PUD requested that Eastern Washington University resurvey the reservoir margin in 1990. Eastern Washington University's results reconfirmed Schalk and Mierendorf's previous findings. The 1990 study suggests that residential sites:

- may exist on level landforms outside of the project area;
- may have formerly been located on the developed terraces above the reach; or
- may be deeply buried (Boreson 1992; Galm 1990).

Prehistoric use of the environments in the Rocky Reach Dam area could have resulted in sites similar to those described for the Rock Island Dam area. However, the probability for discovering village sites within the Rocky Reach segment appears to be lower than in other sections of the project area.

3.11.1.3 Rock Island Dam Area

Washington State University published a comprehensive report based on its reservoir-wide survey and testing program for the Rock Island Dam hydroelectric project in 1982, and Eastern Washington University produced a management plan for the reservoir in 1988 (Lothson et al. 1982; Galm and Masten 1988). Prehistoric sites within the Rock Island reservoir located north of the Wenatchee highway bridge (State Route 285) are situated on low terraces that extend up to 1 mile from the river. Sites in this area include both temporary resource procurement camps and permanent village locations, and the majority of them cluster around the confluence of the Columbia and Wenatchee Rivers. Small shellfish gathering sites occur on the downstream side of alluvial fans, such as at the base of the Rock Island Dam and north of the Wenatchee Flats. The Rock Island rapids area was also an important bighorn sheep hunting area (Lothson et al. 1982).

The area of the reservoir above the dam and south of the Wenatchee highway bridge is located along a more constricted segment of the river, and much of the steeply sloping sides of the canyon lie beneath 6 to 18 meters of water. Five large sites, which archaeologists suggest were summer and fall fishing camps, occupied both prehistorically and ethnohistorically, lie near the dam, which was formerly the Rock Island Rapids (Lothson et al. 1982).

Based on analysis of sediments and stratigraphy in the reservoir area, archaeological sites in the Rock Island Dam study area do not pre-date 13,500 BP. Cascade type projectile points and radiocarbon dates recovered directly from the sites around the reservoir place the earliest datable prehistoric occupation just prior to 3,000

BP. Diagnostic artifacts and radiocarbon dates obtained from various locations around the reservoir suggest continual occupation into the late prehistoric period. Researchers propose that prehistoric peoples living in the Rock Island Dam area used the winter village settlement pattern by 4,500 BP and long mat lodges by 1,100 BP (Galm and Masten 1985, 1988; Lothson et al. 1982).

Prehistoric use of the environments in the Rock Island Dam area could have resulted in domestic archaeological sites, such as villages and camps, along with resource procurement and processing stations for fish, mammals, birds, and edible and utilitarian plants, as well as lithic and mineral raw materials. In addition, trails could connect these places, and burials could occur throughout the project area. Prehistoric use could have resulted in isolated remains that could include projectile points and other artifacts or features such as cache pits, fire hearths, or petroglyphs. These sites provide information regarding settlement and subsistence strategies.

3.11.1.4 Associated Tributaries

The major tributaries that flow into the Columbia River near the Wells, Rocky Reach, and Rock Island reservoirs include the Wenatchee, Entiat, Methow, and Okanogan Rivers. Prehistoric use of the environments in these tributary basins could have resulted in sites similar to those described for the Wells, Rocky Reach, and Rock Island dams, possibly with a greater emphasis on smaller, short-term resource procurement sites.

3.11.1.5 Columbia River System

The Columbia River has served as a focal point for prehistoric settlement and subsistence patterns throughout the plateau's prehistory. A wide variety of wildlife, including deer, elk, sheep, migratory waterfowl, and resident and anadromous fish are part of an abundant resource base that relies on the riparian and aquatic

environments of the Columbia Basin. Prehistoric peoples residing in this region focused their subsistence strategies on these environments to procure food and technological resources. Prehistoric archaeological resources in the project area fit the general pattern seen throughout the Columbia River system area.

3.11.2 <u>HISTORICAL RESOURCES</u>

The following paragraphs provide a general historical context for the Wells, Rocky Reach, and Rock Island dam areas of the Columbia Basin. The subsections that follow contain information specific to each of the reservoir areas and the major tributary basins adjacent to these reservoirs.

The earliest effects of Euroamerican contact appeared in Columbia River native communities before the Euroamericans themselves. Although researchers have not yet determined when epidemic diseases first emerged, some (e.g., Campbell 1989) have suggested that waves of epidemics may have started prior to direct contact. Epidemics of various diseases continued to decrease populations to differing extents. Columbia River Indian groups lost a majority of their population to introduced diseases, such as smallpox, cholera, typhus, chickenpox, or measles, and the health of the survivors was reduced (Boyd 1985; Cook 1955; French 1961). Population estimates for the Okanogan (Sinkaietk), Methow, Isle de Pierre (Rock Island Sinkuse), and Wenatchee Indians prior to the epidemics of the late eighteenth century are 3,200. After disease spread through the area, the combined figure for these groups and the Sahaptin-speakers along the Mid-Columbia River was estimated at 2,674 (Mooney 1928).

The first Euroamerican exploration of the Columbia Basin region was most likely Lewis and Clark's expedition, which traveled through the area of the Snake and Columbia Rivers in 1805 to 1806. Soon after Lewis and Clark returned to St. Louis, Missouri, fur trappers

moved into the northern Columbia Basin region and built Fort Okanogan (Johansen and Gates 1967; Meinig 1968).

In the 1850s, warfare erupted with the interior Native American Tribes, under pressure from an influx of white miners, cattlemen, and settlers. Washington's territorial governor, Isaac I. Stevens, attempted to end these bitter conflicts by holding a council at Walla Walla in 1855. The Indians in attendance ceded the majority of their territory in return for the establishment of lands reserved for the exclusive use of Tribal members. In 1872, Ulysses S. Grant established the Colville Reservation for members of the Colville, Entiat, Methow, Nespelem, Nez Perce, Sinkaietk, Palouse, Sanpoil, Senijextee, Sinkiuse, and Wenatchee Tribes (Ruby and Brown 1986). But the treaties did not eliminate trouble and growing pressure from whites resulted in a series of short, bloody battles.

After 3 years of skirmishing, the U.S. Army increased its presence in the area and compelled the Native Americans to reaffirm the Stevens treaties. The lasting result of this period of upheaval was a slowing of settlement east of the Cascades. It was not until the early 1870s that permanent settlements began to increase in the Columbia Basin. On a trip across the Washington Territory, Governor Stevens called the region "the Great Plains of the Columbia" and maintained it would support a farming population (Johansen and Gates 1967; Meinig 1968).

Before any farming could commence, settlers had to decide how this area of sagebrush and rolling hills could be cultivated. Early cattlemen had overgrazed the free lands, with little concern for the consequences. Farmers arriving in the region, in response to railroad promises of inexpensive land, realized dry land farming was the only method that could be employed. The topography of the region lends itself to growing crops on a grand scale. Wheat was the crop of choice for two reasons: wheat was a dry land crop and, to be profitable, it had to be cultivated in huge

quantities. Both of these conditions existed in the Columbia Basin. Wheat flourished in this limited-moisture environment (Johansen and Gates 1967; Meinig 1968).

Settlers interacted in ways with the Indians that led to changes in their culture. Alcohol, disease, and dislocation disrupted social and political organization. Euroamericans also often hired Indians to act as guides, portagers, as transporters of goods and messages, and to cut timber, and tend herds and crops, all of which took native people away from their traditional subsistence-oriented activities. Euroamericans introduced hay, tobacco, and garden crops into the Columbia Basin by 1860, and researchers speculate that enforced sedentism may have caused Columbia River Indians to adopt agriculture in favor of seasonal root gathering (Boyd 1985; French 1961; Ruby and Brown 1986).

Railroads, which did not service this region until the late 1880s, encouraged wheat growing. Wheat farming communities created demands for inbound consumer goods and farming machinery. Railroads changed the economic picture for local grain growers by shipping wheat at lower prices. At the same time, they guaranteed themselves steady employment for their rail cars. Prior to this time, the cost of transporting a bushel of wheat to England via ship proved less expensive than sending it to American millers (Johansen and Gates 1967; Meinig 1968).

Storage facilities for the harvested winter wheat grew in numbers as the crops increased in volume. Initially, one-floor warehouses were able to accommodate smaller volumes of sacked grain, but later, grain elevators were used to store winter wheat in bulk quantities for shipment by barges on the Columbia River. Barge shipment on the Columbia River replaced railroad cars as the primary means of transporting grain out of the Columbia Basin. No agricultural commodity in the State ranked higher than wheat. By 1910, it represented 44 percent of the total value of Washington crops. Wheat was not the only crop

grown in the region. Irrigation allowed farmers to broaden their agricultural horizons. The first major irrigation project in the Columbia Basin was a private venture called the Sunnyside Canal, which began operating in 1892 (Kirk and Alexander 1990; Meinig 1968; Schwantes 1996).

By the early twentieth century, promoters had recognized the importance of government involvement in irrigation projects. Accordingly, the Federal government acquired area irrigation projects, which became part of a larger effort by the U.S. Reclamation Service. Completion of numerous irrigation projects brought to an end the struggle, started in the early twentieth century, of individual farmers or loosely knit private consortiums to bring water to the parched acres of land in the region. Farmers used the irrigation canals to water hay, apples, cherries, peaches, pears, berries, grapes, peas, beans, and potatoes (Johansen and Gates 1967; Meinig 1968).

As population in the State increased, the demand for beef increased proportionally. Livestock raising became more profitable because railroads could satisfy this demand more efficiently. In the 1870s and early 1880s, most cattle raised in the basin were either driven long distances on foot through Snoqualmie Pass or shipped down the Columbia River on boats. Later, ranchers moved cattle to Seattle or Midwestern markets via the railroad. Rail connections with the Northern Pacific Railroad allowed cattlemen to ship their cattle direct to market without the losses incurred during long drives (Johansen and Gates 1967; Holstine 1994; Meinig 1968).

The massive amounts of electrical power produced by early hydroelectric plants influenced the region in another manner. During World War II, the available electrical power made possible rapid expansion of the wartime and post-war economy. Aluminum for airplanes, sub-assemblies for destroyers, and castings for the Seattle shipyards were produced in the region. Population in the region swelled as more industrial output was required and more jobs were

created. The availability of inexpensive electrical power continued to draw businesses to the region (Johansen and Gates 1967).

3.11.2.1 Wells Dam Area

David Stuart and David Thompson, representing the American Pacific Fur Company, established Fort Okanogan at the confluence of the Columbia and Okanogan Rivers in 1811. After the War of 1812, the fort briefly belonged to the Canadian Northwest Company, which later merged with the Hudson's Bay Company. During this period, the fort served as the gateway to other outposts further north.

The Hudson's Bay Company abandoned the fort in 1860. G. F. Grabert excavated this site as part of his salvage work for the Wells reservoir. His findings confirmed the locations of warehouses, blacksmithing sheds, and the Main House. In addition, Grabert noted that the occupants subsisted primarily on a diet of horse meat, augmented with deer and salmon. Grabert concluded that the abandonment of the fort was planned and orderly, due to the apparent removal of structures and useable lumber and hardware from the site, and a lack of complete artifacts. Indians returned to the area after the Hudson's Bay Company left, superimposing hearths and stone flake debris over several segments of the Euroamerican debris (French 1969: Grabert 1968b; Meinig 1968; Mitchell 1968).

During the historic period, the Wells reservoir area was part of the Methow and Sinkaietk Indian territories. Methow people, whose ancestral lands lay within the Moses, or Columbia reservation accepted allotments in this area. Others followed Chief Moses to the Colville Reservation in the 1870s. The southern extent of Sinkaietk territory is located at the confluence of the Columbia and Okanogan Rivers. The Sinkaietk, whose name means "people of the water that does not freeze," are closely related to the Methow people living just downstream along the Columbia. This group did not participate in the Walla Walla treaty

council, nor did they follow Chief Moses, whose reservation was established in their ancestral lands. The Sinkaietk remained in their homeland after the Moses Reservation was established and then terminated in 1884. Today the Tribe is part of the Confederated Tribes of the Colville Reservation (Ray 1936, 1974; Ruby and Brown 1986).

Beginning in the late 1880s, settlers entered the area and established homesteads. The pioneers found fertile soil, but poor transportation facilities. Riverboat service aboard the City of Ellensburg between Brewster and Wenatchee was sporadic due to high or low water levels or ice (Kirk and Alexander 1990; Meinig 1968).

In the mid-1910s, Alfred Z. Wells established an orchard and company town below the modern location of Wells Dam. The town, now named Azwell, still serves as a fruit packing and shipping center. Further upstream, Pateros is also an orchard center, which grew as a result of its rail link to Wenatchee. The town was originally located in a narrow stretch of the Columbia, but the rise of Lake Pateros behind the Wells Dam in 1967 forced it and the railroad to relocate onto a higher terrace (Dorpat and McCoy 1998; Kirk and Alexander 1990; Ramsey 1973).

Historic period use of the environments in the Wells Dam area could have resulted in sites similar to those described for the Rock Island and Rocky Reach dams.

3.11.2.2 Rocky Reach Dam Area

Within the Rocky Reach Dam area, the Wenatchee, Sinkiuse, Entiat, and Chelan Indians occupied the banks of the Columbia River between the mouths of Swaukane and Antoine Creeks. The Entiat Indian territory, which may have overlapped that of the Wenatchees, centered around the confluence of the Entiat and Columbia Rivers. Further upstream, the Chelan Indians settled around Lake Chelan or moved to the Colville Reservation after the 1855 treaty

negotiations. The Chelan people were the subject of intensive missionary efforts by Roman Catholic priests who used the unusual earthquake of 1872, which blocked the flow of the Columbia for a day, to covert the Indians to Christianity (Ruby and Brown 1986).

Cattle ranchers settled in the foothills above the Entiat valley by 1860. After summer grazing ended, ranchers herded cattle and sheep from the mountains to stock boat moorings or railcars, creating wide drive line trails along the Columbia. A cattle ranch at the mouth of the Entiat River continued operating as late as 1907 (Holstine 1994).

In the mid-1860s, Chinese miners, migrating from the Californian and British Columbian gold fields, excavated a ditch adjacent to the Entiat River, near its confluence with the Columbia, where they placer mined for gold. The Chinese occupied a village along the Columbia across from the mouth of the Chelan River. After mining activities slowed in the area, timber harvests in the foothills increased, creating the need for sawmills in the area. Charles A. Harris constructed the Entiat Mill in 1892. Construction crews for the Rock Island Bridge used timbers floated down the Columbia from this mill. Local farmers also shipped grain down the Columbia. A tram at Orondo hauled grain from the upper terrace of the plateau down to the water. Shippers used the tram from 1902 until 1909, when a branch line of the Great Northern Railroad reached the town of Douglas (Holstine 1994; Hull 1929; Kirk and Alexander 1990; Meinig 1968; Western Historical Publishing Co. 1904a).

In the fall of 1872, an earthquake collapsed a segment of a cliff face, located about 2 miles north of Entiat, into the Columbia River. The river was dammed for several hours, until it broke loose in a "column fifteen feet high." The spot along the Ribbon Cliffs is known today as Earthquake Point (Western Historical Publishing Co. 1904b).

As early as 1904, civic planners in Orondo projected use of hydroelectric power to run the roller in their flour mill. Charles A. Harris constructed one of the first power plants in the area for the Entiat Light and Power Company by 1908. Rocky Reach Dam was one of five hydroelectric power plants erected during the late 1950s and early 1960s on the Columbia (Dorpat and McCoy 1998; Hull 1929; Kirk and Alexander 1990; Western Historical Publishing Co. 1904a).

Historic period use of the environments in the Rocky Reach Dam area could have resulted in sites similar to those described for the Rock Island Dam area.

3.11.2.3 Rock Island Dam Area

Within the Rock Island Dam area, the Sinkiuse and Wenatchee occupied the banks of the Columbia River around Rock Island and the mouth of the Wenatchee River. David Thompson and other fur traders from the North West Fur Company arrived in the Wenatchee valley by 1811, portaging past the Rock Island rapids on July 7.

Indian-Euroamerican relationships in the area deteriorated in the late 1850s when miners murdered the Sinkiuse leader's son. Leadership of the Tribe and other non-treaty Mid-Columbia River Indians passed to Chief Moses. Moses and his followers never occupied the Columbia Reservation (also known as the Moses Reservation) that the U.S. Government set aside for them in 1879. The lands returned to public domain, and Moses and his band moved to the Colville Reservation (Ruby and Brown 1986).

Chief Tecolekun signed the treaty at Walla Walla, but was killed during skirmishes with the U.S. Army in 1858. The Yakima Treaty grouped the Wenatchees with the Yakama because of their association at the Wenatschapam fishing site. This fishery was sold, at the urging of the Yakima agent, to fund an irrigation project on the Yakama Reservation. Beginning in 1911, Wenatchee

people began moving to allotments on the Colville Reservation (Ruby and Brown 1986).

By 1860, the trappers populating the valley had been replaced by Euroamerican and Chinese placer miners. The miners worked claims along the sand and gravel banks and bars of the Columbia and its tributaries, including Chinaman Flat near Malaga. Wenatchee became a trading post for early settlers and miners and was incorporated in 1888. That same year, the first steamboat, the City of Ellensburg, traveled up the Columbia from Pasco to Brewster and used four guy lines to sail past Rock Island.

The Great Northern Railroad entered the region in 1892, which prompted the city to move closer to this new transportation route and to the Columbia River. One year later, the railroad built the Rock Island Bridge, which, along with the Columbia River Bridge located further upstream, is now listed in the National Register of Historic Places. Rock Island Dam was the first hydroelectric project on the Columbia River. Puget Sound Power and Light Company constructed the dam between 1929 and 1933, and its innovative design included three fishladders (Dorpat and McCoy 1998; Holstine 1994; Hull 1929; Kirk and Alexander 1990; Mitchell 1968; Thomas 1975; Tyrell 1916; Writers' Program 1941).

Historic occupation or activities in the Rock Island Dam area could have left a variety of remains, including buildings, structures, sites, and discarded equipment and other artifacts that reflect many types of use. Euroamerican exploration, trade with Indian people, and military activities associated with the Indian uprising of 1855 and 1856 left camp and fort sites. Settlement and farming sites may include cabins, homesteads, farms and ranches, corrals, towns, and school and commercial buildings.

The development of water resources throughout the Columbia Basin for transporting goods, producing electricity, irrigating farmlands, and domestic use could result in such remains as wells, spring boxes, water wheels, flumes, irrigation ditches, pipes, power lines, and poles. Transportation has been particularly important to the culture history of the Columbia River Basin. Artifacts and features associated with Indian and explorer trails, wagon roads, and railroads, including rail and road grade segments, bridges and trestles, tunnels, construction camps, dumps, rail cars, and equipment could exist in the project area. Ethnohistoric sites could be similar to the prehistoric sites described for the Rock Island Dam, with the addition of items of Euroamerican origin. Ethnohistoric use could have resulted in isolated remains that could include projectile points and other artifacts or features such as cache pits, fire hearths, or petroglyphs.

3.11.2.4 Associated Tributaries

Tributary drainages flowing into the Columbia River served as important fishery, hunting, and gathering sites beginning in the prehistoric period and continuing into ethnohistoric times. Miners staked claims in the foothills of the Cascades east of the Columbia River and in the hills surrounding the Okanogan River valley beginning in the 1860s. As the prospects for mining waned in these areas, timber cutting opportunities increased, which continue into the present. Settlers built the first trading post near the mouth of the Wenatchee River. The Wenatchee Flat site, which is actually comprised of several archaeological sites, served as a crossroads and meeting place for Native and Euroamerican peoples. This site is now listed in the National Register (Brown and Wilson 1971).

Historic-period Euroamerican use of the environments in the Wenatchee, Entiat, Methow, and Okanogan River drainage areas could have resulted in sites similar to those described for the Wells, Rocky Reach, and Rock Island dams, with a greater potential for mining and logging camp remains in these areas. Ethnohistoric sites could be similar to the prehistoric sites described for the three dam areas, with the addition of items of

Euroamerican origin. Ethnohistoric use could have resulted in isolated remains that could include projectile points and other artifacts or features such as cache pits, fire hearths, or petroglyphs.

3.11.2.5 Columbia River System

During the historic period, the Columbia River figured prominently in the first direct contact between Native peoples living in the Columbia Basin and Euroamericans. Traders, trappers, and, later, homesteaders followed the Columbia's route to settle in the interior plateau. The river not only contributed food resources to the occupants of the area, but also provided a means of transportation. Later, irrigation systems and hydroelectric power plants constructed along the Columbia brought change to the agricultural and industrial sectors of the region. Historic period archaeological sites, buildings, and structures within the project area fit within the greater pattern of historical resources seen throughout the Columbia River system drainage area.

3.11.3 INDIAN TRADITIONAL CULTURAL PLACES AND RESOURCES

Indian groups generally are concerned about development that occurs within their aboriginal territories. Federally recognized Tribes are concerned about their treaty rights, and the various Tribal groups often want to protect traditional cultural properties which include cultural heritage and traditional religious sites, as well as traditionally used natural resources that occur in geographically limited locations. In addition, Indians consider the natural landscape, and individual elements that comprise it, as spiritually sacred; these include, but are not limited to: cultural sites (archaeological and rock art/feature sites), fisheries, cultural plants, and wildlife. The following paragraphs provide a general ethnohistorical context for the Wells, Rocky Reach, and Rock Island dam areas of the Columbia Basin; the subsistence practices

described below in the Tribal ancestral lands form an integral part of traditional lifeways for these groups (Hanes 1995). The subsections that follow contain information more specific to each of the reservoir areas.

At the time of Euroamerican contact, the Interior Salishan-speaking Sinkiuse, Wenatchee, Chelan, Methow, Entiat, and Sinkaietk Indian groups resided along the Columbia River. These Columbia River Indian groups visited a number of environmental settings during the year's subsistence activities. These people employed various technologies to harvest each resource at the time and place it was available. Both men and women conducted the yearly subsistence work of fishing, gathering, and hunting resources that were consumed fresh and processed for winter storage. Recent work (e.g., Hunn 1990) on the land use of the Indians of the Mid-Columbia River has supplied many details, particularly on the use of plants. Certain ceremonial activities accompanied the yearly harvests especially as the groups welcomed and gave thanks to each of the major food groups of salmon, roots, berries, and others.

Early spring activities began with root collecting as family groups left their winter settlements and camped near root digging grounds. Women used digging sticks and woven bags to collect roots and pack them back to their camps for baking in earth ovens and drying for use as winter supplies. While many roots are sparsely distributed, camas sometimes is concentrated in great meadows where large numbers of people could gather during the harvest season for work and socializing. Family groups carried the dried roots back to the winter settlements and buried them in below-ground caches before they set out again to collect more resources.

Groups then gathered at productive fishing stations along rivers when the spring salmon runs began. The men fished while the women cleaned and dried the fish. As the catch dwindled, the groups again stored their supplies and left in later May to dig a variety of roots including bitterroot, camas, kaus, lupine, wild carrot, onion, and others, establishing camp sites and moving them as the harvest progressed. Groups with access to streams where lamprey eels, suckers, whitefish, and sturgeon ran interrupted their root digging to net or spear these fish (Hunn 1990; Ray 1932; Spier and Sapir 1930; Teit 1928).

Salmon and steelhead runs appeared in the rivers during summer, drawing the groups to return the new root surpluses to their winter caches and harvest the fish. Men pursued their traditional role of fishing and women cleaned and dried the catch. Between fish runs, women gathered and dried berries, including golden currant, gooseberry, dogwood, serviceberry, cranberry, huckleberry, blackberry, and chokecherry (Hunn 1990; Ray 1932).

Beginning in August, Columbia River Indian groups moved into the mountains where they camped through the early fall to harvest and smoke-dry several species of huckleberries. While the women picked and harvested berries, nuts, and moss, men hunted deer, elk, bear, cougar, wolf, and fox in the mountains. The groups likely split at times to allow some to return to the rivers in early September to harvest the fallrun chinook salmon run which provided much of the winter supply. They made a kind of pemmican from pounded salmon and dried berries, mixed with salmon oil. In October, people moved back to their winter settlements, processing the dying salmon of the fall-run chinook salmon run (French 1961; Hunn 1990; Ray 1932; Spier and Sapir 1930).

Columbia River groups maintained permanent winter settlements along protected tributaries to the Columbia and other rivers. Living in semisubterranean houses, mat lodges, or other types of substantial structures, extended families used the winter months to make and repair tools, baskets, clothing, and other necessary items. They visited other groups, conducted religious and social ceremonies, exchanged information

and food surpluses, and repeated the stories of their mythology that instructed children about how to make their living and how to treat other people. Burials of various types were associated primarily with the winter settlements (Hunn 1990).

3.11.3.1 Project Area

Wells Dam Area

Ethnographers list Tkuyatum, located at the mouth of the Okanogan River, about 3 miles upstream from Brewster, and Xantcin, or "little rocky gate," just south of Pateros, as Sinkaietk villages (Ray 1936, 1974; Ruby and Brown 1986).

Rocky Reach Dam Area

Principal Wenatchee villages located in the Rocky Reach study area include Patlkinulu, located on the west bank of the Columbia, 8 miles north of the Wenatchee River, and Ntiatku. meaning "weedy river," at the present site of Entiat. The latter village was jointly used by the Wenatchee and Chelan Indians. Additional villages of the Chelan people included Niyalgen, or "basin in which the creek meanders", north of Winesap at the confluence of Maple Creek and the Columbia River, Nairrp on the west side of the Columbia between Beebe and Bonita, and an unnamed village at the mouth of Antoine Creek. Cwaxtinten, meaning "barking dog," was located near the mouth of Byrd Canyon about 6 miles north of Entiat, and Swaxtciltan, or "horse haven," was situated on a bench above the Columbia River near Tenas George Canyon south of Wagnersburg. A camp called Xaxa'tqu, meaning "dragon jaws," was located 1mile downstream from Wagnersburg on the east side of the Columbia (Ray 1936, 1974).

Rock Island Dam Area

Ethnographers have identified several Indian place names near the Rock Island Project area. A permanent village, Tapiskin or Ngolagom, was located below the dam near the mouth of Colockum Creek. Two villages, Skilkatin and Skwietaktcin, were located near Stemilt and Squillichuck Creeks south of Wenatchee. Nikwikwiestku, "purplish rock," and Skwiltaktcin, "two owls," were located south of the modern Wenatchee business district. These sites were a small summer camp and a summer fishing and gathering village, respectively. The largest of the Sinkiuse villages, Kawaxtcin, meaning "living on the banks (river's edge)," was located at the mouth of Rock Island Creek. A Wenatchee camp named Pat'l'kinu'lu was located near Zena, 8 miles north of the mouth of the Wenatchee River. The villages Stchopas and Kultaktcin, "delta," were situated near the mouth of the Wenatchee River (Ray 1936, 1974).

3.11.3.2 Tributaries

A Wenatchee village named Alota's, which housed about 200 people, was located on the north bank of the Wenatchee River, about half a mile downstream from Monitor. Further north, where Leavenworth is currently located at the mouth of Icicle Creek, the village Tcamaus or "narrow in the middle" served as the principal Wenatchee fishing site. Almost 200 people occupied this village during the summer, but visitors swelled the population to 2,000 to 3,000 during salmon and steelhead runs. The largest Wenatchee village, Ntua'tckam, was located where the town of Cashmere is presently. This permanent village housed 400 residents throughout the year (Ray 1936).

3.11.3.3 Columbia River System

Indian groups generally are concerned about "the totality of the regional landscape," in which "all landscape components participate in a system of

complex inter-relationships" (Hanes 1995). Indians consider the natural landscape, which includes cultural sites, fisheries, cultural plants, and wildlife, as sacred. The subsistence practices described in the paragraphs above take place in Tribal ancestral lands that form an integral part of traditional lifeways for these groups (Hanes 1995). The project area is part of sacred lands whose landscape and features "serve as constant reminders of (the Native people's) spiritual identity" (Hanes 1995).

Throughout the millennia, salmon and steelhead have played an important role in culture of Native American Tribes along the Columbia River (Hanes 1995). During pre-contact times, Tribes established fishing sites where they regularly harvested salmon. The Supreme Court decision U.S. vs. Oregon established that the 1855 treaties of the Yakama, Warm Springs, Umatilla, and Nez Perce Tribes had reserved for these Tribes the right to fish as found in United States vs. Winans. Federal District courts in Washington and Oregon have defined the Tribal fishing rights, on or off their reservations. The court has decided that the Columbia River Tribes were entitled to 50 percent of all harvestable fish destined for the traditional fishing places. In 1974, the U.S. vs. Washington court case, which addressed the fishing rights of Puget Sound Tribes, determined that, for the purposes of measuring harvestable fish, there is no difference between hatchery and native salmon. These court decisions interpreting the Tribes' treaty-reserved fishing rights are the legal framework supporting the Native American traditional practice of harvesting salmon and steelhead along the Columbia River.

3.11.4 <u>Cultural Resources License</u> Requirements

3.11.4.1 Wells Dam and the Management of Cultural Resources

The license under which the Wells Dam is currently operating was issued on July 12, 1962, and amended on September 23, 1982. The original license was issued prior to the 1966 enactment of Section 106 of the Historic Preservation Act, which requires that projects including Federal involvement consider impacts to historic resources that qualify for listing in the National Register. Consequently, the original license included few measures to protect cultural resources. The cultural resource considerations listed in the original license occur in article 44, which prescribed the following measures be taken to protect cultural resources:

The Licensee shall cooperate with the Secretary of the Interior in the preparation of a public use plan for the area and in the possible salvage of the archaeological data and shall, upon written request of the Commission, make available to the Secretary, or to a qualified agency designated by the Secretary, reasonable amounts of monies not to exceed a total of \$10,000 in the preparation of a public use plan and not to exceed a total of \$55,000 to compensate for expenses incurred in archaeological investigations in the pool area.

When the Wells license was amended on September 23, 1982, to address the effects of raising the pool level approximately 2 feet, cultural resource issues were more thoroughly considered (FERC 1982). Under the amended license, the PUD determined that 13 archaeological sites within the affected area were eligible for the National Register. To mitigate for the inundation of these sites, the State Historic Preservation Officer required that data recovery be conducted at the sites before the pool level was

raised. These excavations occurred in 1983 and 1984 (Chatters 1986:iii).

3.11.4.2 Rocky Reach Dam and the Management of Cultural Resources

The Rocky Reach Dam is currently operating under a license that was issued on July 11, 1957. The cultural resource considerations in the license occur in Article 37 and are the same as those listed in the Wells Dam license Article 44. In March 1983, Article 49 was added to the license. This article prescribed the following measures:

The Licensee shall, prior to the commencement of any construction at the project, consult with the Washington State Historic Preservation Officer (SHPO) about the need for any cultural resource survey and salvage work. The licensee shall make available funds in a reasonable amount for any such work as required. If any previously unrecorded archaeological or historical sites are discovered during the course of construction or development of any project works or other facilities at the project, construction activity in the vicinity shall be halted, a qualified archaeologist shall be consulted to determine the significance of the sites, and the licensee shall consult with the SHPO to develop a mitigation plan for the protection of significant archaeological or historical resources. If the licensee and the SHPO cannot agree on the amount of money to be expended on archaeological or historical work related to the project, FERC reserves the right to require the licensee to conduct, at its own expense, any such work found necessary.

3.11.4.3 Rock Island Dam and the Management of Cultural Resources

The Rock Island Dam operates under a license that was issued on January 18, 1989. As part of

the approval of this license, a Cultural Resource Management Plan was drafted to avoid or mitigate impacts to cultural resources within the project area. At the time the license was issued, the Cultural Resource Management Plan was concurred upon by the SHPO, the Colville Tribes, and the Advisory Council on Historic Preservation before being finalized. The primary purpose of the Cultural Resource Management Plan was to "assist the Chelan County PUD in achieving compliance with applicable laws, regulations, and guidance pertaining to the management, protection, and enhancement of cultural resources" (Galm and Masten 1988).

3.11.5 Cultural Resources Summary

The project area (which includes the reservoir areas behind Wells, Rocky Reach, and Rock Island dams, and portions of the of the Wenatchee, Entiat, Methow, and Okanogan drainage basins) contains a wide variety of cultural resources. Although many of these resources have been recorded, additional sites and properties no doubt remain to be discovered. Few of the previously recorded sites have been evaluated for National Register eligibility. Table 3-24 summarizes the types of sites that exist within the project, which were described in the previous subsections of this report, and lists the four National Register listed properties recorded in the project area. While all the site types may be present in all the project areas, their numbers may differ, and not all sites would be eligible for listing in the National Register of Historic Places.

TABLE 3-24. CULTURAL RESOURCE SITE TYPES IN THE PROJECT AREA

							SITE TYPES	es.				:
	ġ.	REHISTOF	PREHISTORIC/ETHNOHISTORIC	ISTORIC				HISTORIC				NATIONAL
PROJECT AREAS	VILLAGE	CAMP	QUARRY	PETROGLYPH	TRAIL	BURIAL	IRRIGATION	TRANSPORTATION	SETTLEMENT	MINING	TCP1	REGISTER-LISTED PROPERTY
Rock Island reservoir	×	×		×	×	×	×	×	×	×	×	Rock Island Railroad Bridge Columbia River Bridge
Rocky Reach reservoir	×	×		×	×	×	×	×	×	×	×	
Wells reservoir	×	X		×	×	×	×	×	×	×	×	
Wenatchee River drainage	×	×	×	×	×	×	×	×	×	×	×	Wenatchee Flat archaeological site
Entiat River drainage	×	X	×	×	×	×	×	×	×	×	×	
Methow River drainage	×	×	×	×	×	×	×	×	×	×	×	
Okanogan River drainage	×	×	×	×	×	×	×	×	×	×	×	

TCP = traditional cultural properties

Source: Compiled from Cultural Resources Inventory and Report Records on file at the Office of Archaeology and Historic Preservation.

3.12 ENVIRONMENTAL JUSTICE

This section was prepared in compliance with Presidential Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, dated February 11, 1994. The purpose of this analysis is to provide information on opportunities provided to minority and low-income populations for participating in the project planning process and to determine whether the proposed alternatives would result in disproportionately high and adverse effects on minority and/or low-income populations.

3.12.1 REGULATORY FRAMEWORK

Executive Order 12898, issued by President Clinton in 1994, provides that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations." In the accompanying memorandum, President Clinton urged Federal agencies to incorporate environmental justice principles into analyses prepared under NEPA and emphasized the importance of public participation in the NEPA process.

In response to Executive Order 12898, NMFS is conducting this environmental review to (1) explicitly consider human health and environmental effects related to projects that may have a disproportionately high and adverse effect on minority or low-income populations; and (2) implement procedures to provide "meaningful opportunities for involvement" by members of those populations during project planning and development. In making determinations regarding disproportionately high and adverse effects on minority and low-income populations, mitigation and enhancement measures and all offsetting benefits to the affected minority and

low-income populations may be taken into account.

3.12.2 MINORITY POPULATIONS

As described in Section 3.7.1, County Demographics, the three-county area has proportionately more persons of Hispanic origin than the State as a whole, largely due to the amount and type of agricultural employment that occurs in the area. The three-county minority population ranges from 14 to 20 percent of the total residential population (U.S. Census 2000).

The majority of the Hispanic population within the three-county area resides in the greater Wenatchee area (75 percent of the Chelan County Hispanic population), the greater East Wenatchee area (60 percent of the Hispanic population in Douglas County), Bridgeport (20 percent of the Douglas County Hispanic population), and Brewster (23 percent of the Okanogan County Hispanic population) (Washington State Office of Financial Management 2001). All three of these towns are located adjacent to the Columbia River, and are within the project area.

Native American populations represent about 1 percent of Chelan and Douglas counties, but comprise 11.5 percent of Okanogan County due to the presence of the Colville Indian Reservation (U.S. Census 2000). The Colville Indian Reservation is located adjacent to and northeast of the project area, with the Columbia River forming the reservation's southern border and the Okanogan River forming the reservation's eastern border.

Section 3.7.2, Tribal Demographics, provides a brief description of the Native American population residing on reservations that utilize the fish resources in the Columbia River. These reservations include the Colville, Yakama, Umatilla, Warm Springs, and Nez Perce

reservations. Total population for all five reservations is 63,190 people; however, not all residents are Native American.

3.12.3 MINORITY AND LOW-INCOME EMPLOYMENT

As described in Section 3.7.3, County Economies, the three-county area has a higher percentage of agriculture, forestry, and fishing employment opportunities compared to the State as a whole. These industries encompass up to 34 percent of employment in the three-county area, and the Hispanic population has a major role in agriculture-related industries. Over 55 percent of the county wages are within this industry. About 8 percent of Native Americans are employed in agriculture, forestry, and fishing, although the primary source of Tribal income is now in the gaming (casino) industry. Average annual wages for Native Americans in the three-county area is \$16,907, as described in Section 3.7.4, Tribal Economies.

Native Americans also fish for subsistence, which is not included as employment data. Native Americans are dependent on subsistence fishing not only to provide a portion of their meals, but also as part of their lifestyle, reflecting deeply held attitudes, values, and beliefs of sharing with others. The opportunity to participate in subsistence activities reinforces cultural and related values in both Native and non-native communities. The distribution of fish and wildlife within Native American communities contributes to the cohesion of kinship groups and to community stability through sharing of resources derived from harvest activities.

3.12.4 OUTREACH TO MINORITY AND LOW-INCOME POPULATIONS

Executive Order 12898 provides that Federal agencies shall ensure meaningful participation of minority and low-income populations in the decision-making process. The implementation of

appropriate public outreach activities and the provision of opportunities for public involvement are key component of compliance with the order. Throughout development of this project, NMFS has undertaken public outreach efforts. These activities are summarized below.

- The Notice of Intent was published in the Federal Register on January 6, 1999, announcing the NEPA process for the Wells, Rocky Reach, and Rock Island Anadromous Fish Agreements and HCPs.
- A scoping brochure was mailed to over 285 individuals, agencies, private businesses, and environmental organizations inviting the public to comment on the EIS. The mailing list included 22 media sources.
- In January 1999, an invitation to participate in the scoping process was advertised in local newspapers of the three-county area. This included the *Douglas County Empire Press* in East Wenatchee and the *Wenatchee World* in Wenatchee, whose distributions cover the areas where the majority of Hispanic and Tribal populations reside (see Section 3.12.2, Minority Populations).
- Public scoping meetings open to the general public were held on January 20, 1999, in Wenatchee, Washington, and January 21, 1999, in Brewster, Washington. Together, these two towns are near where approximately 69 percent of the Hispanic population in the threecounty area reside (approximately 54 percent of the Hispanic population resides in the greater Wenatchee/East Wenatchee/Cashmere area, and approximately 15 percent more resides in the greater Brewster/Bridgeport area) (Washington State Office of Financial Management 2001). In addition, Brewster is within 5 miles of the Colville

- Indian Reservation, which allowed for Tribal member attendance.
- The Tribes were invited to an additional agency meeting held on March 3, 1999, to discuss the EIS issues and alternatives.
- The DEIS public comment period (for written letters) occurred from January 6, 1999, to February 6, 1999, and was later extended to April 1999. Letters received after the scoping period and during the EIS process were also reviewed and used to help define issues, alternatives, and impacts.
- The DEIS was published on December 29, 2000, followed by a 90-day public review comment period during which written letters on the DEIS were received. Copies of the DEIS were sent to 11 towns in the project area, 2 school districts, 7 television stations, 11 newspapers (2 in the areas of low-income population associated with the project), and radio stations in Chelan and Wenatchee. The public was encouraged to review and comment on the DEIS.
- DEIS public meetings were held on March 6, 2001, in East Wenatchee, Washington, where the public was given opportunity to voice comments on the DEIS. Approximately 54 percent of the Hispanic population of the three-county area resides in the greater Wenatchee/East Wenatchee/Cashmere area.
- Following the DEIS public meetings and up through March 2002, NMFS conducted meetings with the project applicants, State and Federal resource agencies, affected Tribes, and American Rivers to ensure that agencies, Tribes, and environmental organizations' concerns were incorporated into the NEPA process. Based on the DEIS comment letters and

- verbal concerns brought forth during the meetings, the PUDs and NMFS agreed to revise the HCPs in 2002.
- A 30-day HCP public comment period for the revised HCPs was held beginning June 25, 2002.

As a result of Tribal comments on the DEIS, NMFS revised the HCPs to address Tribal concerns. The primary Tribal concern was whether NMFS would guarantee the HCPs' goal of no net impact, which included a 7 percent hatchery production level to compensate for unavoidable project mortality. The HCPs were consequently revised to respond to these concerns as described in Section 4.13.3, Environmental Justice, Alternative 3; Section 4.13.17.1, Secretarial Order 3206; and Section 4.13.17.2, Federal Trust Responsibility.



Environmental Consequences

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CHANGES MADE BETWEEN THE DEIS AND FEIS FOR CHAPTER 4

- Chapter 4 was revised to respond to changes in the HCPs that affect the resources differently than as described in the DEIS.
- More information was provided in Chapter 4 where DEIS commenters had questions or requested additional information or discussion of an issue.
- The avian predator control measures sections provide more recent information on this program.
- The hatchery compensation section was revised to reflect changes from the 1998 HCPs to the 2002 HCPs.
- Chapter 4 contains an increased discussion on Pacific lamprey effects from the action alternatives.
- Additional discussion is provided on where the projects are at this time relevant to the HCP phases.
- Corrections and revisions to the projects' relationship to laws and policies, particularly legislation pertinent to Tribal governments (all sections revised and updated) are included in Chapter 4.
- New references were added throughout Chapter 4 to update the information provided in the DEIS.
- Additional Economics, Aesthetics, and Environmental Justice sections are now included in Chapter 4.
- Resource sections within Chapter 4 were revised to reflect the additional mitigation measures that are components of Alternative 2.
- The cumulative effects analysis that was previously within Chapter 4 was moved into a separate chapter (Chapter 5).

Chapter

4

ENVIRONMENTAL CONSEQUENCES

This chapter uses the information presented in Chapter 3 to assess the effects of project operations under each of the three alternatives on land features/geology/soils, fisheries resources, water resources (quantity and quality), vegetation, wildlife, land ownership and use, socioeconomics, economics, aesthetics, recreation, cultural resources, and environmental justice. Note that a summary of the physical, regulatory, and procedural differences among the alternatives is described in detail in Section 2.6, Alternative Comparison. A summary of the environmental consequences of each alternative is presented in Table 2-9.

Alternative 1 represents existing conditions and includes the ongoing mitigation measures necessary to comply with existing permits.

Alternatives 2 and 3 would include the mitigation measures described under Alternative 1, as well as the mitigation measures described under each of these alternatives in Chapter 2 (see Section 2.3.3 [Alternative 2] and Section 2.3.4 [Alternative 3]. No other mitigation measures are associated with the projects.

The Plan Species Accounts, which would occur under Alternative 3, would result in additional new habitat restoration projects in the four tributaries (Methow, Okanogan, Entiat, and Wenatchee). The specific projects are unknown at this time, but each project would undergo various permitting and regulatory reviews at the time the specific project is proposed.

Recommended projects for Plan Species Account funding are described in Section 4.1.3.2,

Associated Tributaries. Mitigation measures to protect sensitive natural resources would be proposed at that time. The reviewing lead agency would then determine the necessary protective measures to permit the project while protecting the environment. In addition, the HCPs include a tributary assessment program that would be utilized to monitor and evaluate the relative performance of projects.

A discussion of the extinction risks for endangered Upper Columbia River spring-run chinook salmon and steelhead is included in Chapter 5 and Appendix E, and the pertinent results are summarized for each alternative in the Threatened and Endangered Species subsections.

This chapter is organized the same as Chapter 3, with the addition of sections to discuss unavoidable adverse effects, irreversible and irretrievable commitment of resources, and the relationship between short-term uses and long-term productivity.

4.1 LAND FEATURES, GEOLOGY, AND SOILS

4.1.1 ALTERNATIVE 1 (No-ACTION)

4.1.1.1 Project Area

Continued operation, maintenance, and planned facility upgrades for the fishways and associated entrances, fishladders, bypass systems (collection entrances and intake screens), turbines, and hatcheries would not result in disturbances to the river bottom. The general geological and soil characteristics of the project area would not be altered by the proposed project modifications. The existing storage and downriver movement of sediments at the three projects would continue.

Soil erosion along the river shoreline would not be expected to occur as a result of the ongoing activities under Alternative 1.

4.1.1.2 Associated Tributaries

Under Alternative 1, no PUD funds would be available to enhance habitat in the Mid-Columbia tributaries. Over the next 50 years, however, habitat restoration within the Wenatchee, Entiat, Methow, and Okanogan watersheds is expected to occur through other various Federal, State, and local funding sources that are aimed to help restore salmon and steelhead runs in the Mid-Columbia River system. The projects would likely include efforts to (1) acquire shoreline areas that are considered important salmonid habitat, (2) remove fish barriers, (3) restore and enhance fish habitat, (4) increase stream flow, and (5) enhance overall water quality.

These projects would help to decrease sediment transport and delivery, increase large woody debris in streams, reduce bank erosion, increase channel bank stability, increase in-pool channels, and contribute to the overall objective of improving stream channel conditions for fish spawning, rearing, foraging, and resting.

Short-term increases in turbidity and sedimentation could occur from construction activities such as culvert modifications, placement of in-channel diversions (rock weirs, roots, boles, boulder barbs, and large woody debris) in streams, and construction projects that may require temporary roads for site access. Over the long term, effects to site geology, soils, and sediments from these projects would return to background levels as a result of natural processes (e.g., reestablished vegetation).

4.1.2 ALTERNATIVE 2

4.1.2.1 Project Area

Section 7 consultation for associated on-site facility improvements for fish passage would not result in significant changes to soils and geologic resources in the project vicinity. If drawdown were to occur (possible under either Alternatives 2 or 3), the effects would be more substantial.

Although reservoir drawdown below the current operating range is not planned or currently recommended for the Wells, Rocky Reach, and Rock Island projects, drawdown to natural river conditions could be proposed under Alternatives 2 or 3. This approach would facilitate the downstream passage of juvenile salmonids if fish passage or survival goals are changed or project monitoring indicates that the goals are not being achieved.

If drawdown is considered a viable option for any dam over the next 50 years, a separate EIS would be prepared with an in-depth analysis conducted for each resource affected.

Increased reservoir drawdown has been considered to improve fish passage conditions at other Columbia Basin projects (BPA et al. 1995a; U.S. Army Corps of Engineers 1992, 2000). The types of reservoir and downstream effects to be expected from large reservoir drawdowns were tested and modeled on the Lower Snake and Elwha rivers (BPA et al.1995a; U.S. Army Corps of Engineers 1992; National Park Service 1995; BOR 1995; FERC 1993b; Stoker and Williams 1991). The drawdown concept also occurs at hydroelectric projects where large reservoir fluctuations are a part of normal operations (Washington Water Power Company 1998; Seattle City Light 1994; Riedel et al. 1992).

Reservoir drawdown would resemble natural river conditions, reducing the area and depth of the project reservoirs. Water flow velocities would increase and channel cross-sectional area would decrease to the original size. The deltas at the mouths of the tributary streams have likely increased in size over time due to the influence of the slack water reservoirs. Sediment entrained in the higher-velocity flows in the tributaries settles out rapidly as velocities decrease at the reservoir. The resulting enlarged deltas could present barriers to fish migrations until new channels are cut through the deltas. This downcutting would increase turbidity levels in the mainstem over the short term.

Drawdown would result in a major increase in erosion to shoreline areas by wave action and other shoreline erosion processes. Increased erosion would occur in the exposed drawdown zone from wind, rain, run-off, and freeze/thaw processes. Additional slumping of steep shoreline areas is common. These erosion processes decline with time as sediment availability decreases and sediment is redistributed in the reservoir.

4.1.2.2 Associated Tributaries

No changes would occur to geologic conditions and soils within the four tributaries as a result of Section 7 implementation under Alternative 2 for the Wells, Rocky Reach, and Rock Island Projects (provided habitat improvements are not required to aid in the recovery of listed species). Independent actions by local, State, and Federal agencies are expected to continue to occur as described under Alternative 1. The potential benefits and adverse effects associated with these activities are described under Alternative 1.

4.1.3 ALTERNATIVE 3

4.1.3.1 Project Area

Similar to the other alternatives, the project improvements planned for fishways, bypass systems, and turbine units under Alternative 3 would not alter project area geology, soils, turbidity, or sedimentation from existing

conditions. Effects from drawdown, as described under Alternative 2, would also occur under Alternative 3 if drawdown were implemented.

4.1.3.2 Associated Tributaries

Alternative 3 would provide PUD funding for fish habitat improvement projects in the four tributaries. This funding would be in addition to other funding sources available to enhance fish habitat in the area. The amount and availability of the PUD funding would be guaranteed under the HCPs, while there would be no guarantee of the amount or availability of funding from other sources. Specific projects identified in the HCP supporting documents (NMFS et al. 1998b) that would help to improve geomorphic conditions in the tributaries include:

- protection of the Lower White River to minimize future effects to the unstable alluvial materials:
- protection of wetlands at Lake Wenatchee and the mainstem of the Methow River to help avoid future increases in sedimentation and turbidity;
- recruitment of large woody debris in the Wenatchee River to restore channel stability;
- restoration of floodplain function in all tributaries to reduce sedimentation and turbidity;
- protection of riparian bottomlands in the Entiat River watershed to reduce the potential of sedimentation, shoreline erosion, landslides, and turbidity;
- restoration of side channel functions in the Methow River to aid in minimizing shoreline slumping and erosion; and
- revegetation and stabilization of the erosive banks on the Okanogan River between the Similkameen River and Omak Creek to avoid future erosion.

Proposed construction projects that could increase turbidity and sedimentation over the short term include modifications of diversion dams and culverts planned at several streams, placement of in-channel habitat structures, and construction projects that may require temporary roads for site access. Over the long term, effects to site geology, soils, and sediments from these projects would be reduced.

Some habitat improvement projects in the four tributaries would likely result in short-term erosion and turbidity effects. Construction-

related projects along river and stream shorelines would likely require a State Joint Aquatic Resource Permit Application (JARPA) and other related permits that evaluate project effects on the existing natural resources, including geology and soils. Through project permitting, BMPs would be identified, and soil erosion and control plans would be required. Review of these construction projects for potential erosion, sedimentation, turbidity, and landslide effects are important considerations to ensure that fish habitat improvements protect existing natural resource conditions, to the extent practicable.

4.2 FISHERIES RESOURCES

Four fish species currently listed as threatened or endangered in the Mid-Columbia River basin are expected to occur within the project area or in areas potentially affected by project operations. These species are:

- Columbia River Distinct Population Segment of bull trout (listed as threatened on June 10, 1998; 63 FR 31674),
- Upper Columbia River spring-run chinook salmon (listed as endangered on August 2, 1999; 64 FR 41835),
- Upper Columbia River steelhead (listed as endangered on August 18, 1997; 62 FR 43974), and
- Middle Columbia River steelhead (listed as threatened on March 25, 1999; 64 FR 14517).

Although adult and juvenile bull trout are occasionally observed passing the projects, little is known about their migratory behavior in the Mid-Columbia River. Specific measures to address the effects of project operations on bull trout are not included in the existing mitigation and compensation programs established through the FERC license and settlement agreements. At this time, informal consultation between FERC, the PUDs, and USFWS has been initiated in an

attempt to develop information specific to this species. This information can then be used to determine appropriate mitigation actions at the projects.

Any effects of the Wells, Rocky Reach, and Rock Island dams on Mid-Columbia River steelhead would most likely be limited to changes in water quality because this species occurs in the Yakima River, located downstream of these hydroelectric projects. Measures implemented at the projects to address water quality would be the same for each of the listed species. For this reason, the following discussions of threatened and endangered species relate specifically to Upper Columbia River spring-run chinook salmon and steelhead.

There are three alternatives being considered in this EIS to protect endangered Upper Columbia River spring-run chinook salmon and steelhead: no-action (Alternative 1), hydropower conservation measures to protect anadromous fish, including Section 7 consultations (Alternative 2), and HCP Section 10 permits (Alternative 3). Although there are fundamental differences between the two action alternatives (Alternatives 2 and 3), both provide protection to the listed species. Alternative 3 would provide the same level of protection to all of the Endangered Species Act-listed and unlisted Plan

species (Upper Columbia River spring-run and summer/fall-run chinook, sockeye, and coho salmon and steelhead). Alternative 1 represents a continuation of the existing conditions, without specifically addressing compliance with the Endangered Species Act for the recovery of listed species. As a result, Upper Columbia River spring-run chinook salmon and steelhead have a high likelihood of extinction under Alternative 1 within the next 100 years. For this reason, Alternative 1 is considered to be non-viable for the protection of the listed species.

Independent (non-PUD-funded) tributary habitat improvements and fish passage survival improvements at the Lower Columbia River dams are expected to benefit Upper Columbia River anadromous fish species. Modifications to harvest regulations and hatchery practices likely to occur over the next 50 years would also benefit these stocks. All of these beneficial actions would occur for all three alternatives presented in this EIS.

Other activities that are likely to affect both the listed and unlisted species are also expected to occur in the region. These activities may or may not be directly linked to the Mid-Columbia River hydroelectric projects. For example, the hatchery programs that were developed to mitigate for inundation by the PUD projects are covered under separate Endangered Species Act consultation proceedings and will continue regardless of the consultations on project operational impacts. Other stipulations outlined in the settlement agreements between the PUDs and the fishery agencies and Tribes would also continue unless specifically modified by Alternative 2 or 3.

Because there are a limited number of measures that can be implemented at the Mid-Columbia River hydroelectric projects to increase fish passage survival, many of the protection measures are expected to be similar for each of the action alternatives. In addition, many of the operational protocols that the projects currently operate under were established through the

collaborative work of PUD, Federal, State, and Tribal biologists, so they are unlikely to change substantially under any of the alternatives. Therefore, the operational measures and protocols discussed under Alternative 1 would also generally apply to the two action alternatives, unless specific differences are identified.

The intent of Alternative 2 is to develop longterm protection and recovery plans for listed species and additional protection for other anadromous species. However, the protection levels are likely to be greater for the listed species due to the additional authority provided to NMFS through the Endangered Species Act. Any means necessary to accomplish this goal would be required at the projects, up to full mitigation of the project effects. The intent of Alternative 3 is to achieve and maintain no net impact on the listed and unlisted Plan species and to establish criteria for implementing correction and mitigation measures to achieve no net impact to the Plan species. These no net impact measures include funding hatchery supplementation and tributary habitat improvements to mitigate for the unavoidable project passage-related mortality.

As discussed previously, the potential measures proposed under Alternative 2 are not currently supported by either FERC or the PUDs. Extensive negotiations would likely be required under Alternative 2 to resolve biological and technical issues before these measures could be implemented. This would likely delay any assistance to listed and unlisted anadromous fish species. It is also likely that ensuing litigation would delay the implementation of protective measures indefinitely. Measures under Alternative 3, however, would be implemented sooner because of PUD support for the HCP procedures, protocols, and standards. Some of the HCP measures have already been implemented, while others would be implemented after the HCPs are approved.

One potential measure that could be recommended under all the alternatives during the

next 50 years (which would have substantial environmental effects on many of the existing natural, physical, and social resources) would be reservoir drawdown to natural river levels. Drawdown would only be available during relicensing of the three Mid-Columbia River projects. The current FERC licenses expire in 2006, 2012, and 2029 for the Rocky Reach, Wells, and Rock Island projects, respectively. Drawdown would be more likely under Alternatives 2 and 3, because of the authority provided by the Endangered Species Act. Regardless of the alternative, drawdown would likely only occur as a last resort because of the extensive socioeconomic and environmental consequences.

Natural river drawdown would help to mimic the natural river conditions that existed prior to the construction of the hydroelectric facilities, potentially returning juvenile and adult survival to pre-dam levels. Although not recommended by any Federal, State, or local agencies at this time, the review of natural river drawdown was requested by organizations during public scoping for this EIS. Consequently, natural river drawdown at the three dams (Wells, Rocky Reach, and Rock Island) has been evaluated at a brief summarizing level to help understand and compare the overall differences between the alternatives.

Drawdown to minimum operating pool, which is an option under the current licenses, has not been shown to increase juvenile survival in the Mid-Columbia River. Drawdown to minimum operating pool would increase water velocities but would not increase flow rates. While there is some (although inconsistent) data showing a correlation between flow and survival in the Mid-Columbia River, there is no information that correlates water velocity and survival. Therefore, minimum pool drawdown was not evaluated in this EIS.

4.2.1 ALTERNATIVE 1 (No-ACTION)

Under Alternative 1, the three Mid-Columbia River hydroelectric projects would operate according to existing FERC license articles, settlement agreements, and interim stipulations. Long-term operational plans would continue to be implemented through existing coordinating committee protocols. The existing settlement agreements stipulate prescriptive measures to mitigate and compensate for the loss of anadromous fish habitat and production due to reservoir inundation, as well as losses associated with anadromous fish passage (juvenile and adult) at the projects. These agreements identify mitigation and enhancement measures, but do not contain specific survival rates or recovery goals for any species.

Alternative 1 includes the following protection measures:

- Measures that allow for efficient upstream passage of adult fish through fishways and reservoirs to minimize the potential for fish injury and pre-spawning mortality. Examples include hydraulic and structural fishway improvements; specifically, ladder modifications and improved attraction flow to help move fish more quickly into the ladder systems and over the dams.
- Measures that provide downstream passage of juvenile salmonids while minimizing fish injury. Examples are spill, bypass systems, and predator control programs.

These measures would be applied at the projects and do not include off-site compensation, such as tributary habitat improvements. Furthermore, these mitigation measures are intended to benefit all anadromous fish species more or less equally, with no specific additional measures implemented for Endangered Species Act-listed species.

Although a Section 7 consultation was completed for the construction of the Rocky Reach juvenile

fish bypass facility, this process was initiated as part of the Rocky Reach HCP. If the HCP is not approved, reinitiation of consultation could occur. Therefore, the stipulations included in the biological opinion are not considered part of Alternative 1. Similarly, the stipulations included in the biological opinion over the Wells Dam interim protection plan are not included in Alternative 1 because the time-frame covered by that consultation has expired.

Implementation and monitoring would be conducted through the Mid-Columbia Coordinating Committee for Rocky Reach (under the Mid-Columbia Proceedings), and through the individual coordinating committees for the Wells and Rock Island projects.

4.2.1.1 Endangered Anadromous Salmonid Species

The effects of the operation of the Mid-Columbia River projects were assessed in the Quantitative Analysis Report (QAR), as summarized in Appendix E. The draft QAR report summarizes available information for Endangered Species Act-listed Upper Columbia River steelhead and spring-run chinook salmon, reviews alternative approaches to estimating the risks of extinction and recovery perspectives, and provides preliminary estimates of the relative risks of extinction under a range of alternative management and climate and environmental scenarios.

The QAR also provides analyses of the potential survival improvements that could be gained throughout the life cycle of listed Upper Columbia River salmonids from hydropower system modifications, enhanced habitat, and changing climate and environmental conditions (i.e., ocean survival). Based on the analyses contained in the QAR, Upper Columbia River spring-run chinook salmon and steelhead have a high likelihood of extinction (i.e., greater than a 95 percent chance within the next 100 years) if the most conservative (1980 to 1994 brood)

survival rates continue into the future.

Continuing the status quo as proposed under
Alternative 1 is unlikely to appreciably change
this conclusion. Refer to Chapter 5, Cumulative
Effects, for a detailed discussion of the QAR
results.

Juvenile Migration/Survival

Protection and recovery measures for fish species listed under the Endangered Species Act would be similar to the mitigation and enhancement measures implemented for unlisted species under Alternative 1.

Wells Dam

Under Alternative 1, the Douglas County PUD would continue to operate the Wells Dam in accordance with the 1990 Wells Settlement Agreement (FERC 1991). The juvenile mitigation measures include:

- minimizing turbine unit and spill gate maintenance during the juvenile outmigration period, and
- operating the surface bypass system as recommended by the Wells Coordinating Committee bypass team to provide bypass operations for 80 percent of the spring and summer migrations.

The juvenile project passage survival rate estimates are greater than the 93 percent juvenile project passage survival goal established in the HCP (see Section 3.2.6.4, Total Project Survival – Juvenile Migrants). These survival rates would apply to approximately 80 percent of the spring and summer migrating smolts under Alternative 1.

The northern pikeminnow removal program was implemented as part of the HCP process, and is not a requirement under the Wells Settlement Agreement. Therefore, it is assumed that this program would not continue under Alternative 1. The avian predator control measures, as defined

in the Cooperative Service Agreement between Douglas County PUD and the USDA Animal and Plant Health Inspection Service, are expected to continue at the Wells Dam and Wells Hatchery. Although these programs are also not a requirement in the settlement agreement, they are relatively inexpensive to operate and were developed through the Mid-Columbia River Coordinating Committee process.

Rocky Reach Dam

Under Alternative 1, the Chelan County PUD would continue to operate Rocky Reach Dam in accordance with measures prescribed in the existing FERC license (FERC 1957a,b, 1968) and consistent with the spill levels set forth in the Fourth Revised Interim Stipulation, now expired (FERC 1996a). Additional protection measures were identified in the Section 7 consultations for spring-run chinook salmon and steelhead (NMFS 2002c). As this was an interim consultation (until relicensing in 2006), and initiated to cover the construction of the juvenile bypass system as a part of the HCP, the measures are not assumed to continue into the future for Alternative 1. Additional measures are, however, expected to be required through the relicensing process. The following mitigation measures are likely to occur under Alternative 1:

- Construct a permanent bypass system.¹
- Operate the turbines within normal power efficiency bands and continue to replace old turbine runners with new reduced-gap runners.
- Spill at a level equal to 15 percent of the daily average flow for 36 days of the juvenile spring-run chinook salmon and steelhead migration period. Up to an additional 6 days

¹ Because the new juvenile bypass system is an integral component of the HCP, for the purpose of comparison it is analyzed in Alternative 3 (HCP) rather than in Alternative 1 (no-action).

of 15 percent spill may be added, if necessary to encompass 90 percent of the Okanogan River sockeye salmon run. In the summer, spill at a level equal to 10 percent of the daily average flow for a total of 34 days between June 15 and August 15.

• Continue to implement predator control programs.

These mitigation measures are expected to improve fish passage efficiency for juvenile fish at the Rocky Reach Dam, particularly with respect to surface bypass system development. It is assumed that continued refinement of the bypass system would result in survival rates for spring-run chinook salmon and steelhead that are similar to those observed in the bypass systems at the Lower Snake River dams (estimated at 97 to 98 percent). Because of the configuration of the dam, which forms a cul-de-sac on the powerhouse side of the river, most of the fish that pass through the bypass would otherwise likely pass through the turbines, which have a lower survival rate (estimated between 90 and 93 percent). The bypass system offers an alternative passage route for juvenile fish, which tend to accumulate at the downstream end of the cul-desac (near Turbine Units 1 through 3).

Although spillway survival is usually expected to be the same or slightly higher than bypass survival (98 to 99 percent), the Rocky Reach spillway is not particularly effective at the lower spills implemented to date. From 8 to 19 percent of the fish are typically passed in 15 percent spill (Steig and Adeniyi 1997; English et al. 1998c, 1999). Other mainstem Columbia and Snake River dams typically achieve much higher spillto-fish passage ratios at this spill volume. The apparent inefficiency of the Rocky Reach spillway is believed to be associated with the configuration of the dam. Juvenile fish that enter the cul-de-sac (adjacent to the powerhouse) tend to pass the project through the bypass system or the turbine units rather than moving back upstream to encounter the spillway.

The survival estimates developed as a result of PIT-tag evaluations conducted in 1998 and 1999 represent the best available information regarding both the direct and indirect effects of the Rocky Reach Hydroelectric Project on the survival of juvenile spring-run chinook salmon and steelhead (see Table 3-4). These PIT-tag studies indicate that juvenile spring-run chinook salmon survival is at least 85.9 percent (see Section 3.2.6.4, Total Project Survival – Juvenile Migrants). Bickford et al. (1999, 2000b, 2001) estimated chinook salmon survival at 93.9 percent and steelhead survival at between 95.9 and 96.7 percent. However, these evaluations included only a single-release strategy, which does not include all the sources of mortality occurring at the dam (see Table 3-4).

Single release-recapture models can only measure project effects from the point of release to the PIT-tag detector (which is typically located within a juvenile bypass channel or fish handling facility). Thus, some of the mortality associated with passage via turbines or the spillway or the indirect mortality occurring downstream of the project is not included in these survival estimates. Therefore, these survival estimates are likely somewhat higher than would have been measured if the paired release-recapture model were utilized. Future studies to determine project survival estimates would likely be based on paired release methodologies.

Survival estimates are required for all species, over a variety of river flow and project operational conditions, to reliably assess project-related mortality rates. Future studies could demonstrate different survival rates than those recently observed.

Despite the improvements in juvenile fish passage efficiency, additional protection and enhancement measures could be implemented at the project to improve the survival of listed species. Under Alternative 1, additional measures can be implemented through the pending Mid-Columbia Proceeding with FERC and during relicensing.

However, Alternative 1 would provide approximately the same level of protection to the Endangered Species Act-listed fish as the unlisted species. As a result, Alternative 1 is likely to result in lower survival for the listed species compared to the expected survival that would likely result under Alternatives 2 or 3.

The current predator removal programs appear to be altering the population structure of northern pikeminnow in the project area. These programs are expected to result in a substantial reduction in predation rates on migrating anadromous salmonid smolts and are expected to continue under Alternative 1.

Rock Island Dam

Under Alternative 1, the Chelan County PUD would continue to operate Rock Island Dam in accordance with the existing FERC settlement agreement and license articles (FERC 1987a, 1989a). Currently, the primary methods for maximizing juvenile spring-run chinook salmon and steelhead survival at the Rock Island Dam are spill and predator control measures. The existing spill program developed as a result of provisions in the Rock Island Settlement Agreement and is based on a Fishery Conservation Account of \$2.05 million (1986 dollars adjusted for inflation). Through this process, the agencies and Tribes can request spill at any time, with the lost revenue to the PUD subtracted from the account. Once the spill equivalent of \$2.05 million has been subtracted from the account, the PUD will have fulfilled its yearly obligation under the settlement agreement.

The predator control program includes removal of northern pikeminnow from the forebay and tailrace, predatory bird hazing, and avian predator exclusion wires strung across the tailrace. These activities are expected to reduce the overall losses of Plan species associated with passage at the project.

Mitigation measures that are expected to continue under Alternative 1 include:

- predator control programs,
- providing daily average spill levels as requested by the fishery agencies and Tribes through the Fishery Conservation Account, and
- evaluating spillway modifications to increase spill effectiveness.

These mitigation measures are expected to maintain current juvenile fish passage survival rates at the Rock Island Dam.

The survival estimates developed as a result of PIT-tag evaluations conducted from 1998 through 2002 represent the best available information regarding both the direct and indirect effects of the Rock Island Dam on the survival of juvenile chinook salmon and steelhead. Juvenile springrun chinook salmon survival was estimated at between 88.9 and 95.6 percent, based on total project survival PIT-tag evaluations conducted on hatchery-reared yearling fall-run chinook salmon between 1998 and 2002 (see Table 3-5). Total project survival of juvenile steelhead was estimated at 95.8 percent based on evaluations conducted with hatchery-reared juvenile steelhead in 1999 (Stevenson et al. 2000). Direct juvenile salmonid survival estimates calculated at the spillway and powerhouses (91.1 and 94.5 percent, respectively), although not conclusive, are consistent with the trends identified in PIT-tag survival evaluations.

Implementing the mitigation measures under Alternative 1 would not allow for the continued evaluation of project effects on listed species, and from the limited data currently available, would not result in sufficiently high survival to ensure the continued existence of spring-run chinook salmon. Without continued research and evaluation and improved passage survival measures, Alternative 1 is expected to result in lower long-term survival for anadromous fish species than either Alternative 2 or 3.

Adult Migration/Survival

The Douglas and Chelan County PUDs operate three of the five non-Federal Mid-Columbia River hydroelectric projects. Upper Columbia River spring-run chinook salmon and steelhead from the Methow and Okanogan Rivers must pass four Lower Columbia River Federal hydroelectric projects and all five of the Mid-Columbia River dams to reach their spawning grounds. The Entiat River fish runs must pass the lower river projects and four Mid-Columbia River projects; the Wenatchee River fish runs must pass the lower river projects and three of the five Mid-Columbia River dams. Although the Mid-Columbia River steelhead stock does not migrate past any of the five Mid-Columbia River projects, they are subject to variations in flow and other water quality parameters influenced by project operations at the Mid-Columbia River projects (and the upstream Federal projects). Although the combined effects of all five Mid-Columbia River projects on each of these species are unknown at this time, there could be cumulative effects. For example, physiological stresses associated with water quality conditions in the reservoirs or fish passage conditions at the dams could cumulatively affect the survival of juveniles or adults.

The direct mortality of adults passing individual projects is likely minimal under normal operating conditions. However, each dam presents the potential for migration delays, increasing energy expenditure as fish move through the fishladders, increasing incidences of involuntary fallback through the dam, and increasing exposure to high concentrations of dissolved gases. Increased migration rates through the relatively slack water reservoirs may, however, counteract some of these effects.

The effects (positive or negative) and magnitude of the cumulative effects to adult anadromous fish are largely unknown at this time. While existing technologies allow adults to be tracked during their migrations past the projects, and in some cases all the way to the spawning areas, with few exceptions (e.g., death resulting from falling back through the projects), they do not indicate the cause of any observed mortality. As new technologies become available, it is likely that additional assessments would be conducted under Alternative 1 as well as both action alternatives.

Adult passage information (such as the time spent immediately downstream of the dam, success at passing into the collection channel and fishway entrances, and time spent passing through the ladders) is typically assessed using radiotelemetry techniques. Although previous studies have not determined a direct relationship between project passage times and reproductive success, reducing passage times is expected to reduce energy expenditures and improve the likelihood that adult fish would survive to spawn.

Radio-telemetry studies only provide information for tagged fish that pass the project. Failure to pass a project may result from project operations (such as passage facility design, attraction water effectiveness, or complicated downstream flow patterns. At the same time, fish that fail to pass a project could be destined for downstream spawning areas or may have been injured previously during their upstream migration. In addition, tag failure or tag loss can be misinterpreted as fish failing to pass a project, resulting in an overestimate of project effects.

There are limited data available to assess the survival of adult anadromous salmonids passing the Mid-Columbia River projects. Radiotelemetry evaluations conducted between 1993 and 1998 contain the bulk of the available data, but survival was not specifically addressed in any of these studies.

Project operations are not expected to directly affect adult migrations in tributary streams. However, migration delays or injuries resulting from project passage could potentially reduce the ability of fish to reach their natal spawning grounds. Bjornn et al. (2000) reported that radio-

tagged adult salmon and steelhead that fell back at one or more Columbia and Snake River dams escaped to tributary streams at significantly lower rates than fish that did not fall back. There was also a higher rate of unaccounted-for fish among those that fell back. In addition, they observed that fish that fell back multiple times tended to escape to tributaries at lower rates than fish that fell back one time, particularly for upriver stocks.

Typical reservoir water level fluctuations are not expected to affect the ability of adult fish to enter the mainstem tributaries. If reservoir drawdown was implemented to improve juvenile survival, access to these tributaries by upstream migrating adults may initially be limited due to alluvial sediments that have accumulated at the confluences to the mainstem Columbia River.

The effects of project operations on the survival of migratory bull trout are largely unknown, although adult bull trout have been observed using the adult fishways. Preliminary radiotelemetry evaluations in the project area observed no substantial impacts relative to project passage (see Section 3.3.8.1, Life Histories – Bull Trout/Dolly Varden). While none of the tagged fish fellback below the dam after navigating through the fishladders, some of the tagged fish migrated back downstream through the projects after spending weeks to several months in upstream tributaries. Although the downstream passage route at the projects is unknown, there were no indications of dam passage impacts. Migration rates and apparent upstream passage delays are similar to other anadromous salmonids, and the tagged fish entered tributary streams prior to the spawning season. As with other radiotelemetry studies, however, any potential effects on spawning success could not be determined (see Section 3.2.5.1, Upstream Migration of Adults). Radio-telemetry studies are ongoing for bull trout in an effort to determine if, or to what extent, bull trout are being affected by project operations.

Wells Dam

To minimize and mitigate for potential effects of project operations on adult spring-run chinook salmon and steelhead under Alternative 1, the Douglas County PUD would:

- maintain and operate adult passage facilities at the project according to criteria stipulated in the 1990 Wells Settlement Agreement (FERC 1991);
- investigate entrance and ladder conditions to ensure that access is not impeded during project passage. Should a structural problem be identified within the fishladder, Douglas County PUD has agreed to improve ladder operations with specified criteria to minimize delays at the dam;
- operate the spill and turbine units in a manner that optimizes the attraction flows at the fishway entrances and improves adult passage, while meeting requirements for juvenile fish passage; and
- conduct fish passage studies to identify and correct potential adult passage problems.

Radio-telemetry studies indicate that the median passage time for adult spring-run chinook salmon at the Wells Dam is similar to that observed at other Mid-Columbia River projects. However, passage times for steelhead appear to be substantially faster than for spring-run chinook salmon or other anadromous fish species. Initial evaluations found that the majority of the passage delays at the project were associated with operation of the brood collection traps on the east and west ladder fishways. In addition, prior to implementing collection gallery operational modifications, fish would delay within the fishway collection galleries (Stuehrenberg et al. 1995). Trap operations increase the total project passage times by 5 to 10 times over those observed during non-trapping periods (English et al. 2000).

Despite the relatively fast passage time for steelhead at the project, the Okanogan River bound steelhead experience some delay at the mouth of the Okanogan River due to elevated water temperatures in the Okanogan River. There is no evidence suggesting that these delays are related to project operations, and only indirect data suggesting that the delays may be affecting overall spawning success.

There is little information to suggest that substantial injuries are occurring to adult fish passing through the fishladders under normal operating conditions. Therefore, the greatest potential for injury and mortality to adult fish is believed to be associated with fish falling back through the project after initially passing upstream. Although the fallback rate for springrun chinook salmon is relatively low, there are no data to determine if there is any effect on survival. The fallback rate of adult radio-tagged steelhead at Wells Dam was 6.8 percent in 1999 (English et al. 2001) (see Section 3.2.5, Adult Survival at Projects).

Rocky Reach Dam

Mitigation measures for adult spring-run chinook salmon and steelhead under Alternative 1 would include maintaining and operating the adult passage facility according to criteria in the existing FERC license and subsequent stipulations. Evaluations have shown that at least 80 percent of the adult sockeye and summer-run chinook salmon passage delays occur in the fishway entrance pools. It is likely that similar delays occur in this area for spring-run chinook salmon and steelhead as well (see Section 3.2.5, Adult Survival at Projects), although there is only indirect information suggesting that these factors may be affecting overall spawning success.

Limited data exist to assess the survival of adult salmon and steelhead fallbacks or steelhead kelts passing downstream through the project. However, it is likely that adult passage survival through the juvenile bypass system or the spillway is greater than through the turbine units.

Rock Island Dam

Under Alternative 1, the Chelan County PUD would maintain and operate the adult passage facilities at the project according to criteria included in the existing FERC license and settlement agreement. The effects of these actions on adult fish would be similar to those described for the Rocky Reach Dam (see Section 3.2.5, Adult Survival at Projects).

Adult Reservoir Spawning

There is no available information suggesting that substantial spawning activity of adult spring-run chinook salmon or steelhead occurs in the Wells, Rocky Reach, or Rock Island reservoirs. However, some steelhead spawning might occur in the tailraces (similar to summer/fall-run chinook salmon spawning) or at the mouths of the mainstem tributaries. If spawning occurs in these areas, the operation of the Wells, Rocky Reach, and Rock Island powerhouses may have some effect on steelhead spawning.

Although bull trout are occasionally observed in the project areas, they are generally believed to spawn in small headwater tributaries. Therefore, project operations are only expected to affect bull trout spawning for those fish that migrate past one or more of the dams to reach their spawning grounds. However, potential effects during passage are unknown at this time (see discussion of potential effects in the Adult Migration/ Survival section).

Tributary Habitat Improvements

Under Alternative 1, the PUDs would not fund off-site mitigation, including habitat-related projects to enhance adult spawning and juvenile rearing in the Mid-Columbia River tributary streams. As with the other two alternatives, some tributary habitat improvement projects are expected to occur through funding sources other than the PUDs.

Hatchery Production

The hatchery programs currently supported by the Chelan and Douglas County PUDs were developed to mitigate for the loss of spawning habitat with the inundation of the mainstem Columbia River by the project reservoirs, and for estimated losses associated with fish passage at the projects. Under Alternative 1, these facilities would likely continue to be funded by the PUDs and operated by WDFW in accordance with their various license articles, settlement agreements, and interim stipulations, as well as the policies and guidelines of the State and Section 10 permits issued under the provisions of the Endangered Species Act. The Section 10 permits describe the efforts implemented to avoid and minimize the effects that hatchery-reared fish may have on Endangered Species Act-listed salmonids. These efforts include protocols for adult collection and spawning, rearing and release strategies, fish health management programs, and environmental monitoring. These protocols are based on sound fish husbandry principles, and are therefore expected to be followed for all hatchery stocks and would equally benefit unlisted fish species.

Wells Dam

Under Alternative 1, the Douglas County PUD would continue to fund the current hatchery compensation programs for spring-run chinook salmon at the Methow Fish Hatchery and for steelhead at the Wells Hatchery and off-site acclimation facilities according to stipulations in the 1990 Wells Settlement Agreement (FERC 1991). Operation of the Wells Hatchery program has previously received a Section 10 permit (#1094, issued to WDFW on February 4, 1998), and a biological opinion concerning NMFS's issuance of the permit has been completed. Operation of the Methow Fish Hatchery was considered in the review of a Section 10 permit (#1196 to WDFW) and in a biological opinion prepared for NMFS's issuance of that permit (NMFS 2002c). Therefore, Endangered Species Act requirements would be satisfied for the PUD- funded hatchery compensation program under Alternative 1.

The Methow Hatchery was built as part of the 1990 Wells Dam Settlement Agreement and was intended to compensate for an assumed total project mortality rate of 14 percent (including reservoir and dam passage). Steelhead production was also increased at the Wells Hatchery to compensate for 14 percent steelhead dam passage loss. However, recent juvenile survival studies suggest an average mortality of about 3.8 percent. Under Alternative 1, the compensation levels would be adjusted to reflect the actual fish passage losses, according to stipulations in the Wells Settlement Agreement (FERC 1991). Based on the measured mortality rates, there would be about a 70 percent reduction in hatchery production, compared to existing hatchery production.

Since inception in 1992, the Methow Hatchery has been operating under a supplementation strategy. Under this program, the genetic integrity of the Methow River chinook stock supercedes the hatchery production goals established in the 1990 Wells Settlement Agreement. The hatchery program also includes the development of spring-run chinook salmon broodstock management protocols and the volitional release of smolts from acclimation ponds located in tributary streams.

Rocky Reach Dam

The Turtle Rock, Rocky Reach Annex, and Chelan Falls hatchery facilities are owned and funded by the Chelan County PUD and operated by the WDFW in accordance with Section 10 permit #1094 (issued to WDFW). A biological opinion concerning NMFS's issuance of that permit has been completed (NMFS 1998b). The Section 10 permit describes the efforts required to avoid and minimize effects to the listed species. However, this permit will be replaced by permit #1395 in 2002 or 2003, which might contain additional restrictions to further minimize the potential effects on listed species. Therefore,

although Chelan County PUD has committed to sufficiently fund the hatchery program to mitigate for the estimated project-related losses, hatchery protocols or production restrictions might not allow that level of supplementation.

Under Alternative 1, the Chelan County PUD would continue to fund the operation and maintenance of these hatcheries at a level equivalent to the 1996 budgeted operation and maintenance costs, adjusted annually for inflation. The existing production capacities are believed to more than compensate for juvenile fish passage losses and for original inundation behind Rocky Reach Dam. The hatchery program would likely continue to be operated by WDFW, in a manner consistent with the recovery of spring-run chinook salmon and steelhead populations.

Rock Island Dam

The Eastbank Hatchery complex and associated satellite facilities are owned and funded by the Chelan County PUD and operated by WDFW. The spring-run chinook salmon programs were considered in the review of Section 10 permit #1196 (issued to WDFW) and in the biological opinion concerning NMFS's issuance of that permit (NMFS 2002c). The Section 10 permit requirements are similar to those described previously, although this permit will likely be modified or amended within a year. Therefore, Endangered Species Act requirements would be satisfied for the PUD-funded hatchery compensation program under Alternative 1.

Under Alternative 1, Chelan County PUD would continue to fund the operation and maintenance of these hatcheries in accordance with the Rock Island Settlement Agreement. Funding would be maintained at a level equivalent to the 1998 budgeted operation and maintenance costs, adjusted annually for inflation. The existing production capacities are believed to compensate for original inundation behind Rock Island Dam and more than compensate for juvenile fish passage losses at the project.

Although Chelan County PUD has committed sufficient funding levels to mitigate for the estimated project-related losses, hatchery protocols or production restrictions might not allow that level of supplementation throughout the 50-year time-frame.

Associated Tributaries

Effects associated with hatchery supplementation in the Mid-Columbia River tributaries include the potential interactions between hatchery and wild stocks (competition, predation, and disease transmission) and potential changes or alterations to the genetic integrity and diversity of both populations. Competition between hatchery and wild juvenile fish may occur where food and space requirements overlap or are limited. However, there is little information to document the magnitude or significance of these potential interactions in the Mid-Columbia River region.

There is also little information on the potential predation of hatchery fish on wild fish, although the typical size difference between hatchery and wild fish suggests that such interactions are possible. Although disease transmission fish to fish (horizontal transmission) can occur in hatcheries or other areas where affected and unaffected fish are held in close contact, there are limited data suggesting that this is a substantial problem in the riverine environment. All three of these potential interactions would be greatest at or near the hatchery release points, and would be expected to decrease over time and space as the fish migrate downstream.

The potential risk of changing the genetic integrity and diversity of wild and hatchery fish populations would be minimized by the utilization of appropriate hatchery management practices. The current strategies of the Mid-Columbia River hatchery program were developed to be consistent with the NMFS interim policy on artificial propagation under the Endangered Species Act. Therefore, no additional effects are expected from the Mid-Columbia River hatchery programs.

Monitoring and Evaluation

Under Alternative 1, the PUDs would continue to implement the research and monitoring plans identified in their license articles, settlement agreements, and interim stipulations. The primary purpose of these plans is to ensure that the mitigation measures are being implemented in accordance with existing licenses and agreements.

Wells Dam

Under Alternative 1, the Douglas County PUD would conduct the following monitoring and evaluation measures developed through consultation with the Wells Coordinating Committee:

- Continue to assess juvenile run timing at the Wells Project with real-time hydroacoustic monitoring, and to periodically verify these data with fyke-net evaluations.
- Evaluate the adequacy and effectiveness of the hatchery programs.
- Evaluate juvenile fish passage efficiency at the project using the best available techniques. Douglas County PUD evaluated fish passage efficiency of the bypass system in 1990, 1991, and 1992.
- Periodically evaluate adult passage through the project fishways.
- Provide adult fish counts on a 24-hour basis.

Rocky Reach Dam

Under Alternative 1, the Chelan County PUD would conduct the following monitoring and evaluation measures:

- Continue to assess juvenile run timing using the juvenile fish bypass sampler.
- Assess the injury, mortality, and descaling of juvenile fish passing through the bypass system.

Provide adult fish counts on a 24-hour basis.

Rock Island Dam

Under Alternative 1, the Chelan County PUD would conduct the following monitoring and evaluation measures:

- Continue to assess juvenile run timing using the Powerhouse 2 juvenile fish sampler.
- Monitor the condition of fish passing through the bypass for injury, mortality, and gas bubble disease rates.
- Continue to evaluate spillway modifications to improve juvenile fish passage efficiency and minimize total dissolved gas levels downstream.
- Provide adult fish counts on a 24-hour basis.

4.2.1.2 Other Anadromous Salmonid Species

Alternative 1 provides the same level of protection for all anadromous fish species, regardless of their listing status under the Endangered Species Act. The protection criteria are based primarily on project operational guidelines rather than survival rate criteria.

Juvenile Migration/Survival

Wells Dam

The effectiveness of the Wells Dam juvenile fish protection measures for non-Endangered Species Act-listed species, provided by Alternative 1, would continue to be evaluated primarily through fish passage efficiency criteria. The fish passage efficiency criteria, established in the 1990 Wells Settlement Agreement, are set at 80 percent for spring migrants and 70 percent for summer migrants (FERC 1991).

According to hydroacoustic evaluations conducted between 1990 and 1992, the Wells bypass system has an average fish passage

efficiency of about 92 percent for spring migrants and about 96 percent for summer migrants (Skalski 1993). Therefore, the established passage efficiency criteria are being met under existing conditions. In addition to meeting these criteria, the overall survival for the unlisted anadromous species are expected to be similar to those discussed for the listed species. Dam passage survival has been calculated at between 97.4 and 98.6 percent for all anadromous salmonids (see Table 3-3). Although these survival rates were developed using primarily data from other projects in the basin, they are in line with the estimates of project passage survival from project-specific survival studies (see Table 3-4). Therefore, dam passage survival is expected to be similar for all the alternatives at the Wells Dam (Table 4-1).

Rocky Reach Dam

Under Alternative 1, the Chelan County PUD would continue to operate Rocky Reach Dam in accordance with the existing FERC license and interim stipulations for the protection of unlisted species.

The Rocky Reach Dam juvenile fish protection procedures would be primarily prescriptive in nature, with no specific outcome-based performance (i.e., survival) goals. The main goal of the juvenile fish protection measures at Rocky Reach Dam for unlisted species would be to complete the construction of the permanent bypass system.

Although the bypass system is currently being built, it is an integral part of the HCPs and is therefore discussed under Alternative 3. Prior to the completion of the bypass system, Chelan County PUD would provide interim protection to juvenile migrants through the use of spill.

Although the mitigation measures for Rocky Reach Dam are not based on survival rates under Alternative 1, survival rates can be estimated to allow comparisons between the EIS alternatives. In lieu of specific survival data for each

anadromous fish species passing the Rocky Reach Dam, the available dam-specific data (as well as data from other projects in the Columbia River basin) were used to estimate survival for each species. Based on this general information, juvenile fish dam passage survival ranges from 90.8 to 94.1 percent (Table 4-2). Specific project passage survival studies, which include indirect and delayed mortality, indicate total project survival rates between 85.9 and 96.7 percent (see Table 3-5).

Rock Island Dam

Under Alternative 1, Chelan County PUD would continue to operate Rock Island Dam in accordance with their existing FERC license and the Rock Island Settlement Agreement (FERC 1987a). The primary method for maximizing juvenile anadromous fish survival at the Rock Island Dam is through spill. Spill passage is believed to be the most benign passage route for most species (Chapman et al. 1994a), although the resulting increases in downstream total dissolved gas can impact aquatic resources, including anadromous fish. The spill program would be implemented based on the Fishery Conservation Account described previously (see Section 4.2.2.1 under Juvenile Migration/ Survival).

Similar to the juvenile fish mitigation measures for unlisted species described for the Rocky Reach Dam, the mitigation programs at the Rock Island Dam are prescriptive, and do not include survival goals. For the purposes of comparing alternatives, however, survival under Alternative 1 can be estimated.

Based on general information, juvenile salmonid dam passage survival for all species is expected to range between 91.1 and 94.5 percent (Table 4-3). While these estimates do not include indirect and delayed mortality factors, project-specific survival studies indicate survival rates of between 88.9 and 95.6 percent for chinook salmon and 95.8 percent for steelhead (see Table 3-5). Survival for the remaining species was calculated

based on the available (on-site and off-site) route-specific information. They ranged from 91.5 to 94.4 percent for sockeye and coho salmon, and 91.1 to 94.1 percent for summer/fall-run chinook salmon (see Table 4-3).

Adult Migration/Survival

Several radio-tag studies indicate that the adult fishways at the Mid-Columbia River dams are generally effective at providing passage for anadromous adult fish under normal operating conditions, although passage times for summer/fall-run chinook salmon appear to be longer than for spring-run chinook salmon and steelhead (see Table 2-4). Summer- and fall-run chinook salmon are also likely to be more vulnerable to delays because their migrations extend further into the summer, when water temperatures are higher. Higher temperatures increase the fish's metabolic rate, resulting in greater energy expenditures. Their migration period also tends to be closer to their spawning periods, allowing less time to compensate for migration delays. Although these factors are suspected to increase the rate of pre-spawning mortality for some of the anadromous species, there is no data to verify or quantify the effects.

The adult fishways at the PUD projects are operated according to criteria established in existing FERC licenses, settlement agreements, and interim stipulations.

NMFS has determined that total per-project mortality of Upper Columbia River adult springrun chinook salmon and adult steelhead is likely between 1.2 and 3.2 percent (NMFS 2002d, 2000a, 1998a). However, it is not currently possible to differentiate between hydrosystem caused mortality and natural mortality (which undoubtedly occurs) with the technologies available (see Section 3.2.5.1, Upstream Migration of Adults). Per-project mortality estimates based on available information include both sources. Therefore, mortality rates attributable to the effects of hydroelectric projects

JUVENILE FISH SURVIVAL CALCULATIONS BY PASSAGE ROUTE AND ALTERNATIVE AT WELLS DAM **TABLE 4-1.**

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	PROPOR	PROPORTION OF FISH THROUGH EACH PASSAGE ROUTE	H THROUGH ROUTE ¹	PROPORTION ROUTE DURING	PROPORTION SURVIVING EACH PASSAGE ROUTE DURING SPILL/BYPASS OPERATIONS	H PASSAGE OPERATIONS ¹	NON-SPILL/BYPASS	ALL ROUTES
SPECIES	SPILLWAY PASSAGE (%)	BYPASS PASSAGE (%)	TURBINE PASSAGE (%)	SPILLWAY SURVIVAL (98-99%)	BYPASS SURVIVAL (98-99%)	TURBINE SURVIVAL (90-93%)	OPERATIONS TURBINE SURVIVAL ² (90-93%)	COMBINED— TOTAL SURVIVAL (%)
Alternative 1 ³								
Subvearling Chinook	ΑN	96.4	3.6	A A	75.6 – 76.4	2.6-2.7	18.0 – 18.6	96.2 – 97.6
Yearling Chinook	A	92.4	9.7	A V	72.4 – 73.2	5.5 – 5.7	18.0 – 18.6	95.9 – 97.4
Sockeye	Ϋ́	92.4	9.7	A A	72.4 – 73.2	5.5 - 5.7	18.0 – 18.6	95.9 – 97.4
Coho		92.4	9.7	ĄZ	72.4 – 73.2	5.5 - 5.7	18.0 – 18.6	95.9 – 97.4
Steelhead Alternative 2 ⁴	N A	92.4	7.6	V	72.4 – 73.2	5.5 – 5.7	18.0 – 18.6	95.9 – 97.4
Subyearling Chinook	t. 6.	96.4	2.3	6.1	93.5 - 94.5	2.1	6.0	97.7 – 98.8
Yearling Chinook	2.7	92.4	6.4	2.6 – 2.7	89.7 – 90.6	4.4 – 4.5	6.0	97.5 – 98.7
Sockeye	2.7	92.4	4.9	2.6 - 2.7	89.7 – 90.6	4.4 – 4.5	0.9	97.5 – 98.7
Coho	2.7	92.4	6.4	2.6 – 2.7	89.7 – 90.6	4.4 – 4.5	6.0	97.5 – 98.7
Steelhead Alternative 3 ⁵	2.7	92.4	6.4	2.6 – 2.7	89.7 – 90.6	4.4 – 4.5	6.0	97.5 – 98.7
Subyearling Chinook	N A	96.4	3.6	Ą	89.8 – 90.7	3.1 - 3.2	4.5 – 4.7	97.3 – 98.4
Yearling Chinook	A A	92.4	7.6	Y Y	86.0 – 86.9	6.5 – 6.7	4.5-4.7	97.0 – 98.3
Sockeve	Ą	92.4	7.6	N A	86.0 - 86.9	6.5 – 6.7	4.5 – 4.7	97.0 – 98.3
Coho		92.4	7.6	Ą	86.0 - 86.9	6.5 - 6.7	4.5 – 4.7	97.0 - 98.3
Steelhead	Ą	92.4	7.6	NA	86.0 - 86.9	6.5 – 6.7	4.5 – 4.7	97.0 – 98.3
					-			

Based on assumed survival and passage rates through the available passage routes.

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Turbine survival estimate for the time period not covered by spill and/or bypass operations.

⁹⁹ percent of spring and summer migration covered by 7 percent flow through the bypass and 33 percent through the spillway. 95 percent of spring and summer migration covered by 7 percent flow through the bypass. = Not available. 80 percent of spring and summer migration covered by 7 percent flow through the bypass.

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JUVENILE FISH SURVIVAL CALCULATIONS BY PASSAGE ROUTE AND ALTERNATIVE AT ROCKY REACH DAM TABLE 4-2.

	PROPORT	PROPORTION OF FISH THROUGH EACH PASSAGE ROUTE ¹	н тнкоисн Route ¹	PROPORTION ROUTE DURING	PROPORTION SURVIVING EACH PASSAGE ROUTE DURING SPILL/BYPASS OPERATIONS	H PASSAGE OPERATIONS ¹	Non- SPILL/BYPASS	A I BOUTES
SPECIES	SPILLWAY PASSAGE (%)	BYPASS PASSAGE (%)	TURBINE PASSAGE (%)	SPILLWAY SURVIVAL (98-99%)	BYPASS SURVIVAL (98-99%)	TURBINE SURVIVAL (90-93%)	OPERATIONS TURBINE SURVIVAL (90-93%)	COMBINED— TOTAL SURVIVAL (%)
Alternative 1 ³								
Subvearling Chinook	12.0	₹	88.0	9.9 – 10.0	Ϋ́	66.9 – 69.2	14.0 – 14.4	90.8 – 93.6
Yearling Chinook	13.8	A A	86.2	11.4 – 11.5	A A	65.6 – 67.7	14.0 – 14.4	90.9 – 93.7
Sockeye	21.5	Š	78.5	17.8 - 18.0	Ϋ́	59.7 – 61.7	14.0 – 14.4	91.5 – 94.1
Coho	13.8	N A	86.2	11.4 – 11.5	A A	65.6 – 67.7	14.0 – 14.4	90.9 – 93.7
Steelhead Alternative 2 4	12.5	A A	87.5	10.4 – 10.5	NA	66.5 - 68.8	14.0 - 14.4	90.8 - 93.6
Subyearling Chinook	51.2	20.0	28.8	49.7 – 50.2	19.2 – 19.4	25.7 – 26.6	6.0	95.4 – 97.0
Yearling Chinook	31.6	34.2	34.2	30.7 - 31.0	32.8 – 33.2	30.5-31.5	6.0	94.9 – 96.6
Sockeye	51.2	11.7	37.1	49.7 – 50.2	11.3 – 11.4	33.0 – 34.1	6.0	94.9 – 96.6
Coho	31.6	34.2	34.2	30.7 - 31.0	32.8 – 33.2	30.5-31.5	6.0	94.9 – 96.6
Steelhead Alternative 3 ⁵	30.4	49.7	19.9	29.5 – 29.8	47.7 – 48.2	17.7 – 18.3	6.0	95.9 – 97.3
Subyearling Chinook	12.0	36.0	52.0	11.2 - 11.3	33.2 - 33.5	44.5 – 45.9	4.5 – 4.7	93.3 – 95.4
Yearling Chinook	13.8	43.1	43.1	12.9 - 13.0	39.7 – 40.1	36.9 – 38.1	4.5 – 4.7	93.9 – 95.8
Sockeye	21.5	18.9	59.6	20.0 - 20.2	17.4 – 17.6	51.0 – 52.7	4.5 – 4.7	92.9 – 95.1
Coho	13.8	43.1	43.1	12.9 - 13.0	39.7 - 40.1	36.9 - 38.1	4.5-4.7	93.9 - 95.8
Steelhead	12.5	62.5	25	11.6 – 11.8	57.6 – 58.2	21.4 – 22.1	4.5-4.7	95.1 – 96.7

Based on assumed survival and passage rates through the available passage routes.

Not available. ₹

Turbine survival estimate for the time period not covered by spill and/or bypass operations.

⁸⁴ percent of spring and summer migration covered by 15 percent flow through the spillway.

⁹⁹ percent of spring and summer migration covered by 40 percent flow through the spillway and a 6 kcfs sluiceway bypass.
95 percent of spring and summer migration covered by 15 percent flow through the spillway. NOTE: This does not include expected survival improvements from three weeks of 25% spill for sockeye during the spring migration for all spring migrating species.

JUVENILE FISH SURVIVAL CALCULATIONS BY PASSAGE ROUTE AND ALTERNATIVE AT ROCK ISLAND DAM **TABLE 4-3.**

	Ркоро	PROPORTION OF FISH THROUGH EACH PASSAGE ROUTE ¹	юи GH EA CH E¹	PROPORTI ROUTE DUR	PROPORTION SURVIVING EACH PASSAGE ROUTE DURING SPILL/BYPASS OPERATIONS	CH PASSAGE	NON-SPILL	ALL ROUTES
SPECIES	SPILLWAY PASSAGE (%)	FIRST POWERHOUSE PASSAGE (%)	SECOND POWERHOUSE PASSAGE (%)	SPILLWAY SURVIVAL (98-99%)	FIRST POWERHOUSE SURVINAL (90-93%)	SECOND POWERHOUSE SURVIVAL (90-93.5%)	WINDOW TURBINE SURVIVAL ² (90-93.5%)	COMBINED— TOTAL SURVIVAL (%)
Alternative 1 ³								
Subyearling Chinook	16.5	9.1	74.4	12.9 – 13.1	6.6 – 6.8	53.6 – 55.7	18.0 – 18.6	91.1 – 94.1
Yearling Chinook	23.7	1.8	68.2	18.6 – 18.8	5.8 – 6.0	49.1 – 51.0	18.0 - 18.6	91.5 - 94.4
Sockeye	24.0	13.4	62.6	18.8 - 19.0	9.7 - 10.0	45.1 – 46.8	18.0 – 18.6	91.5 - 94.4
Coho	23.7	1.8	68.2	18.6 - 18.8	5.8 - 6.0	49.1 – 51.0	18.0 – 18.6	91.5 - 94.4
Steelhead Alternative 2 ⁴	24.6	5.1	70.3	19.3 – 19.5	3.7 – 3.8	50.6 – 52.6	18.0 – 18.6	91.6 – 94.5
Subyearling Chinook	0.09	0.1	30.9	58.2 – 58.8	8.1 – 8.4	27.5 – 28.6	6.0	94.8 – 96.7
Yearling Chinook	59.2	1.8	32.7	57.4 – 58.0	7.2 – 7.5	29.1 – 30.3	6.0	94.7 – 96.7
Sockeye	0.09	13.4	26.6	58.2 - 58.8	11.9 – 12.3	23.7 – 24.6	6.0	94.8 – 96.7
Coho	59.2	1.8	32.7	57.4 - 58.0	7.2 – 7.5	29.1 – 30.3	6.0	94.7 – 96.7
Steelhead Alternative 3 ⁵	61.6	5.1	33.3	59.8 – 60.4	4.5 – 4.7	29.7 – 30.8	6.0	94.9 – 96.8
Subyearling Chinook	30.0	1.6	60.9	27.9 – 28.2	7.8 – 8.0	52.1 – 54.1	4.5 – 4.7	92.3 - 95.0
Yearling Chinook	29.6	8.1	62.3	27.6 – 27.8	6.9 – 7.2	53.3 – 55.3	4.5 – 4.7	92.2 – 95.0
Sockeye	30.0	13.4	56.6	27.9 – 28.2	11.5 – 11.8	48.4 – 50.3	4.5-4.7	92.3 – 95.0
Coho	29.6	6.1	62.3	27.6 – 27.8	6.9 – 7.2	53.3 – 55.3	4.5 – 4.7	92.2 – 95.0
Steelhead	30.8	5.1	64.1	28.7 – 29.0	4.4 – 4.5	54.8 – 56.9	4.5 – 4.7	92.3 – 95.1

Based on assumed survival and passage rates through the available passage routes.

Turbine survival estimate for the time period not covered by spill and/or bypass operations.

⁸⁰ percent of spring and summer migration covered by 16% and 11% flow through the spillway, respectively, via the Fishery Conservation Account process. 99 percent of spring and summer migration covered by 40% flow through the spillway. 95 percent of spring and summer migration covered by 20 percent flow through the spillway.

are undoubtedly lower than those presented, but to an unknown extent.

Wells Dam

Previous radio-telemetry evaluations at Wells Dam indicate that summer/fall-run chinook salmon experience passage delays negotiating the collection channel and entering the ladder (see Table 2-4). However, recent modifications to ladder operations have indicated a substantial reduction in the passage times of adult summer/fall-run chinook salmon. Closing the side entrances to the ladder resulted in passage time reductions from 52.5 to 20.6 hours in 1997 and from 38.5 to 19.0 hours in 1998. There is no indication that sockeye salmon experience substantial delays passing the project. Although there are no known direct sources of mortality to adult salmonids at the Wells Dam under normal operating conditions, mortality could occur as a result of fallback through the spillway, bypass, or turbine units. However, the magnitude of these potential effects is unknown.

Under Alternative 1, the Douglas County PUD would maintain and operate adult passage facilities in accordance with the 1990 Settlement Agreement (FERC 1991). The implementation of these plans would be expected to minimize the effects to adult fish passing the project by ensuring that fishways are being operated with the established criteria, thereby minimizing passage delay. These operations are expected to be similar for all three alternatives.

Rocky Reach Dam

Under Alternative 1, the Chelan County PUD would maintain and operate adult passage facilities according to the existing FERC license. As with the fishways at the Wells Dam, there is some evidence to suggest that sockeye and summer-run chinook salmon experience passage delays in the entrance pools of the Rocky Reach fishway (Stuehrenberg et al. 1994). However, there are no data to suggest any direct injury or mortality resulting from fish passage under normal operating conditions (refer to Section

3.2.5, Adult Survival at Projects for more information).

Rock Island Dam

Under Alternative 1, the Chelan County PUD would maintain and operate adult passage facilities in accordance with the existing FERC license and settlement agreement. The potential problems associated with passage through these fishways are attributed to delays in locating the entrances, and in the junction pools. However, the available data suggest that passage conditions (passage time and fallback rates) are similar or slightly better at Rock Island Dam than at Rocky Reach or Wells dams (refer to Section 3.2.5, Adult Survival at Projects for more information).

Adult Reservoir Spawning

No direct effects of project operations on sockeye salmon spawning are expected because sockeye tend to spawn well upstream of the projects in streams associated with Lake Wenatchee and Lake Osoyoos. Summer/fall-run chinook salmon are expected to exhibit substantial spawning activity in the Mid-Columbia River reservoirs; however, the spawning habitat is primarily restricted to upper reservoir or tailrace areas. The potential spawning-related effects of project operations include deposition of fine sediments that may reduce incubation and spawning success, scour or relocation of gravel near the tailraces, and fluctuations in pool elevation. Total dissolved gas levels resulting from spill at the projects may increase stress levels in migrating fish and may potentially result in an increased incidence of pre-spawning mortality.

Only summer/fall-run chinook salmon commonly spawn in the mainstem Columbia River, and the majority of spawning occurs after the voluntary summer spill period has ended and total dissolved gas levels meet water quality standards. For those fish that do spawn when spill is occurring, depth compensation should provide sufficient refuge from these dissolved gas levels to protect the spawning adults.

No substantial impacts of project operations on reservoir-spawning species are expected, because of the projects' limited ability to control river flows. In addition, any impacts are expected to be similar to existing conditions.

Hatchery Production

As discussed previously, the hatcheries funded by the Chelan and Douglas County PUDs are operated by WDFW in accordance with policies and guidelines of the State and Section 10 permits issued by NMFS under the provisions of the Endangered Species Act. The strategies of incorporating natural broodstocks into the artificial production programs are expected to strengthen the natural spawning populations and improve the genetic diversity in the hatchery stocks. These hatchery program changes might result in fewer total hatchery fish produced in the short term, particularly for diminished stocks that cannot support broodstock programs, but in the long term, these changes should result in stronger and healthier stocks throughout the region. Potential effects to the anadromous species related to the hatchery programs are expected to be similar for all alternatives, as discussed previously (see Section 4.2.2.1 under Hatchery Production).

<u>Tributary Habitat Improvements and Monitoring</u>

The previous discussions of tributary habitat improvements and monitoring programs related to the Endangered Species Act-listed stocks are also applicable to the unlisted species under Alternative 1 (see Section 4.2.2.1 under Tributary Habitat Improvements).

4.2.1.3 Resident Fish Species

Project Areas

Little is known about the effects of project operations on resident fish populations in the

Mid-Columbia River. In general, the most important effects are related to spawning success, early survival of juveniles, and food supply. Typically, the most substantial influence on all of these issues is the fluctuation in water levels related to hydroelectric project operations. Because all of the Mid-Columbia River PUD projects are run-of-the-river dams, they have limited ability to control these levels. Normal reservoir fluctuations are minor, ranging from 3 to 10 feet. The reservoirs are generally narrow, with relatively steep banks, so these water level fluctuations have limited influence on the wetted area of the river. The minor exceptions are the shallow bar areas associated with tailraces, the mouths of tributary streams, and the occasional backwater or off-channel ponds.

The Wells reservoir is larger and shallower than the other reservoirs, and the water level fluctuations are greater. Therefore, the effects of water level fluctuations are also greater at the Wells Dam and are more prone to influence resident fish populations. This is particularly true in the relatively wide and shallow area near the mouth of the Okanogan River (Brewster Flats). Drawdown would likely result in a greater reduction in habitat for resident fish in the Wells reservoir than in the other two reservoirs. However, there is little information on resident fish population sizes and population trends in any of the reservoirs to quantify the actual effects of water level fluctuations or other project operations.

Under Alternative 1, some predator control programs would continue to be implemented. These activities would also have substantial effects on resident fish populations in the reservoirs. The programs target the removal of northern pikeminnow, which have been shown to be the primary predator fish on juvenile salmonids in the basin. When salmonid smolts are not migrating downstream, however, the northern pikeminnow diet consists of a greater proportion of non-salmonid prey, as well as an increase in non-fish species. Predator reductions

would result in the increased survival of salmonid smolts passing the projects, as well as increased survival and reduced competition for other resident fish species in the reservoirs.

Other anadromous or migratory species that occur in the Mid-Columbia River area are white sturgeon and Pacific lamprey. There are no indications that other fish pass the projects in appreciable numbers. Therefore, it is unlikely that project operations would substantially affect these other resident fish populations.

Pacific Lamprey

Pacific lamprey are a migratory species that pass the Mid-Columbia River projects through all available routes. There is no specific information concerning the mortality rates of this species passing the projects, although they are particularly susceptible to impingement on turbine intake diversion screens. The only screens that are currently in operation at the Mid-Columbia River dams are at turbine units 1 and 2 at the Rocky Reach Dam. These screens were installed to increase the efficiency of the bypass system. Substantially fewer fish pass through the turbine units that are currently unscreened, so fewer fish are available for diversion with additional screens. Under Alternative 1, no additional turbine intake screens are expected to be installed at any of the three projects.

Other effects on lamprey from project operations are unknown, although passage through the turbines is likely to result in some injuries and direct or indirect mortality. Fyke net data collected at the Wells, Rocky Reach and The Dalles dams indicate that lamprey tend to be spatially separated from juvenile salmonids as they pass through turbine units (Hatch and Parker 1996; Peven 2002 personal communication). Because lamprey do not have a swim bladder, they cannot easily regulate their position in the water column and tend to be closer to the bottom than the surface. This behavior likely makes them less likely to benefit from juvenile salmonid surface bypass systems at Wells or Rocky Reach

dams. They might also pass more readily through the turbines than the surface-oriented spill bays. Therefore, a high proportion of lamprey likely pass the Mid-Columbia River projects through the turbines.

Although lamprey tend to migrate at night when predation rates are likely lower, passage through the turbine units may subject migrating juvenile lamprey to increased predation risks. Both avian and piscivorous predators prey on juvenile lamprey and are attracted to prey that have been concentrated spatially and temporally by dam operations (Hatch and Parker 1996). As a result, current predator control measures implemented at the PUD projects under Alternative 1 would likely benefit lamprey.

In 1996, 2,121 adult lamprey were counted passing Rock Island Dam, while only 979 were counted at Wells Dam (Hatch and Parker 1996). Although this suggests that a substantial population may be spawning in the Wenatchee River system, counting lamprey tends to be problematic because they migrate near the bottom, along the edges of the adult fishways, or pass through the fish counting weirs, making them difficult to observe. Even comparing adult salmonid fishladder counts (which are much more reliable numbers) between projects can be problematic for estimating tributary spawning escapements (Carie 1996).

White Sturgeon

Little is known about the population levels of white sturgeon in the Mid-Columbia River region, although limited sampling suggests that the populations are small (see Section 3.2.8.1, Life Histories). The mainstem dams present substantial migration barriers to this species because they do not readily use fishladders. Therefore, the populations of sturgeon in the Mid-Columbia River are considered to be isolated or semi-isolated populations. Isolated fish populations are generally considered less genetically fit to withstand habitat or population disturbances, although the overall extent or

severity of these effects is unknown. In addition, the extent that sturgeon pass the projects and the potential effects of dam passage are unknown.

The predator control measures implemented at the projects under Alternative 1 would likely benefit sturgeon populations in the reservoirs. Northern pikeminnow have been found to prey on sturgeon eggs, and walleye prey on sturgeon larvae in areas downstream of McNary Dam (Pacific States Marine Fisheries Commission 1992).

Associated Tributaries

Project operations under Alternative 1 would not alter tributary habitat or resident fish populations that occur there. However, migratory species that move between the tributary and reservoir areas might be affected by project operations, as discussed previously. In addition, hatchery fish planting activities would result in temporary increases in competition for habitat and food resources with resident species. The extent of this competition and the effects on resident fish populations are currently unknown. The increased use of volitional release strategies for hatchery fish from acclimation ponds would reduce the densities of hatchery fish in the tributaries and minimize the potential negative interactions with resident fish. Under these strategies, hatchery fish leave the ponds when they are ready to begin their downstream migrations and are therefore unlikely to spend much time in the tributaries.

4.2.2 ALTERNATIVE 2

Under Alternative 2, the Wells, Rocky Reach, and Rock Island hydroelectric projects would be operated according to existing FERC licenses, settlement agreements, and interim stipulations as modified by voluntary or involuntary proposals under license reopener clauses or at relicensing which would be reviewed by NMFS's biological opinions for listed species. These biological

opinions would specifically address two fish species listed under the Endangered Species Act: Upper Columbia River spring-run chinook salmon and steelhead. If additional anadromous fish species are listed under the Endangered Species Act in the future, protection from the Section 9 take prohibitions would be addressed independently.

The existing FERC licenses and settlement agreements include measures to mitigate for the loss of anadromous fish habitat and production due to reservoir inundation, as well as losses associated with anadromous fish passage (juvenile and adult) at the projects. As discussed under Alternative 1, listed species have a high likelihood of extinction under these measures alone. All measures necessary to prevent extinction and aid in the recovery of listed species, up to full mitigation for the project effects, would be utilized under Alternative 2.

4.2.2.1 Endangered Anadromous Salmonid Species

The effects of the operation of the Mid-Columbia River projects were assessed in the draft Quantitative Analysis Report (QAR). A summary of the QAR has been provided in Appendix E. The report summarizes available information for Endangered Species Act-listed Upper Columbia River steelhead and spring-run chinook salmon, reviews alternative approaches to estimating the risks of extinction and recovery perspectives, and provides preliminary estimates of the relative risks of extinction under a range of alternative management and climate and environmental scenarios.

For listed fish, measures implemented under Alternative 2 are expected to meet the Alternative 3 juvenile dam passage survival standards at a minimum, while additional on-site measures could be required to ensure that the ongoing operation of the PUD-owned projects would not jeopardize the continued existence of Endangered Species Act-listed steelhead and spring chinook

salmon. Alternative 3 establishes a no net impact goal for each project, consisting of a 91 percent combined adult and juvenile fish project passage survival goal, with hatchery compensation and off-site mitigation programs to account for the 9 percent unavoidable loss.

Juvenile Migration/Survival

The effectiveness of protection and recovery measures for spring-run chinook salmon and steelhead would be based on project-specific survival estimates; fish passage efficiency estimates (if direct estimates of survival were not available) and the long-term recovery status of the species. In general, survival goals are based on the analyses contained in the QAR.

Conditions for the survival and recovery of the listed anadromous fish species are expected to be similar for both Alternatives 2 and 3, although the measures and implementation schedule necessary to reach or approach these conditions might be different for each of the alternatives. Under Alternative 2, Endangered Species Act consultations would ensure that the PUD projects do not jeopardize (appreciably reduce the likelihood of both the survival and recovery) the continued existence of the Endangered Species Act-listed species. Any measures could be required to achieve this goal, although litigation could delay implementation. In comparison, protective measures for unlisted species would be similar to those described under Alternative 1, because of the uncertainty associated with NMFS' ability to obtain additional measures through either license reopener or relicensing processes for unlisted species. However, measures implemented under Alternative 2, to protect the listed species, would likely provide additional protection for unlisted species.

Similar to Alternative 1, reservoir drawdown is a potential (although remote) protection measure for anadromous fish species under Alternative 2. However, this option could only occur as a result of relicensing procedures. Rocky Reach is due

for relicensing in 2006, while the relicensing of the Wells and Rock Island projects would occur by 2012 and 2029, respectively.

Drawdown could result in faster juvenile migration speeds due to higher water velocities, slightly lower water temperatures, increased turbidity, and potentially lower total dissolved gas levels over the long term. Each of these factors is expected to increase the survival of migrating juvenile fish. In the short term, however, lower water levels would increase the density of predator fish and increase the incidence of predator/prey encounters and substantially increase turbidity and sedimentation over existing conditions. Each of these factors is expected to decrease the survival of migrating juvenile fish. As a result of the water quality impacts described above (lower water temperatures and total dissolved gas levels), adults should also benefit in the long term, and only be minimally affected in the short term by increased turbidity sedimentation. However, increased water velocities would decrease the migration rates of adult fish and increase the energy expenditures needed to migrate through the area. As a result, the net effect of drawdown on adult salmonids is uncertain.

A detailed site-specific evaluation and separate EIS would be required to determine the benefits and environmental effects of drawdown under any of the alternatives, before the measure could be implemented.

Wells Dam

Under Alternative 2, the Douglas County PUD would operate the Wells Dam in accordance with the existing license articles and the 1990 Settlement Agreement (FERC 1991), as well as any additional measures required as a result of relicensing, license reopener proceedings, or Endangered Species Act consultations.

The juvenile fish protection measures implemented under Alternative 2 would be similar to those already implemented (Alternative

1) and would be similar to several of the proposed actions identified for Alternative 3.

Juvenile project survival has been measured at 99.7 percent for hatchery-reared yearling springrun chinook salmon (Bickford et al. 1999) (see Table 3-5). Similar studies conducted in 1999 and 2000 on hatchery steelhead resulted in total project survival estimates of 94.3 and 94.6 percent, respectively (Bickford et al. 2000a, 2001). Thus, the existing conditions meet the fish passage efficiency criteria established in the 1990 Wells Settlement Agreement, satisfy projected recovery goals established in the QAR, and exceed the 93 percent juvenile project passage survival criterion proposed in the HCP. Therefore, there would likely be no additional requirements to increase turbine survival or bypass efficiencies at Wells Dam under Alternative 2, unless new research demonstrated a need for higher survival goals.

Increased spill levels are expected to be the primary method of increasing juvenile fish passage survival rates, if necessary. It is estimated that up to 40 percent of river flow could be spilled at Wells Dam without exceeding the total dissolved gas water quality standards. This estimate is based on the ratio of 1 percent of saturation increase for every 4 percent increase in spill, and a typical forebay total dissolved gas level of 110 percent during the spill season (Klinge 2002).

Rocky Reach Dam

Under Alternative 2, the Chelan County PUD would continue to operate Rocky Reach Dam in accordance with the existing license articles, as well as any additional measures required as a result of relicensing, license reopener proceedings, or Endangered Species Act consultations. Although the Rocky Reach Fourth Revised Interim Stipulation (FERC 1996a) has expired, the unlisted anadromous fish species would be protected by the continued implementation of measures established through

reopener proceedings, settlement agreements or at relicensing.

The protection and enhancement measures discussed for Alternative 1 would also likely occur under Alternative 2, and are expected to increase the survival of juvenile fish passing Rocky Reach Dam. Alternative 2 also includes a 6,000-cubic-feet-per-second (cfs) sluiceway (in the event that the current bypass system does not adequately avoid a jeopardy determination). This sluiceway would draw water and fish from the forebay at the downstream end of the powerhouse cul-de-sac. The sluiceway channel would be cut into the cul-de-sac wall and would carry the water and fish in an elevated channel over the existing structures and roadways to discharge at some downstream location on the right bank.

Challenges to this concept included the unknown capacity to effectively draw fish past the powerhouse intakes to the location of the sluiceway entrance. It would also be difficult to control water velocity within this large flow without making the structure extremely long with a gradual slope. Although preliminary modeling evaluations have been conducted on the feasibility of this type of bypass, it would likely take several years of modeling to design and construct the system. This would be followed by several years of fish passage evaluations to determine if it is better than the current bypass system.

Verification of juvenile fish passage survival might be required to determine if adequate protection was being provided to reduce the likelihood of extinction of the listed species. It is assumed that continued refinement of the bypass system would result in improved survival rates for spring-run chinook salmon and steelhead. Until the level of survival is verified, however, or if additional protection measures were needed to protect the listed species, spill would likely be increased at the Rocky Reach Dam. It is estimated that up to 40 percent of river flow could be spilled at Rocky Reach Dam and still remain

within the total dissolved gas water quality standards. However, total dissolved gas abatement structures might be required to allow the necessary spill levels, while remaining within the water quality criteria.

Under Alternative 2, NMFS would determine, through the Endangered Species Act consultation process, the most appropriate survival goals and protection measures (in the event of a jeopardy determination) for the protection of threatened and endangered species. NMFS would modify these survival goals as necessary to ensure that the listed stocks of anadromous fish were not jeopardized by the projects or their operations. Specific protection measures for threatened and endangered species would not occur under Alternative 1.

Survival studies in 1999 and 2000 estimated overall survival through the Rocky Reach reservoir and dam at 95.9 and 96.7 percent for hatchery-reared steelhead smolts (Bickford et al. 2000a, 2001) (see Table 3-5). As previously discussed, however, these evaluations were conducted using the single-release PIT-tag methodology, which does not include all of the sources of mortality associated with passing the project (see Section 4.2.1.1, Endangered Anadromous Salmonid Species). A radiotelemetry evaluation in 1999 estimated total project passage survival of run-of-the-river steelhead at 96.6 percent, although the accuracy of radio-telemetry studies for estimating juvenile fish passage survival is unknown at this time (Stevenson et al. 2000).

A paired-release PIT-tag evaluation, conducted in 1998 with hatchery-reared yearling fall-run chinook salmon, estimated survival at 85.9 percent (Eppard et al. 1999) (see Table 3-4). Bickford et al. (1999) estimated chinook survival at 93.9 percent, although this evaluation was a single-release PIT-tag study. Accurate survival estimates are required over a variety of river flow and project operational conditions to reliably assess project-related mortality, and future studies

could demonstrate different survival rates than those recently observed. If a consistent pattern of lower survival is demonstrated, or if the survival rates are not deemed adequate to prevent the extinction of the listed species, NMFS would impose additional protection measures.

The existing predator control program at Rocky Reach Dam is expected to continue under Alternative 2. This program includes the removal of northern pikeminnow from the forebay and tailrace areas, as well as predator bird hazing and exclusion wires strung across the tailrace. Between 1994 and 2002 over 51,000 predatory northern pikeminnow were removed from the vicinity of Rocky Reach Dam under this program (West 2001; West 2002 personal communication). The predator control program is expected to result in a significant reduction in predation rates on migrating salmon and steelhead smolts.

Rock Island Dam

Under Alternative 2, the Chelan County PUD would continue to operate the Rock Island Dam in accordance with the FERC license and Rock Island Settlement Agreement (FERC 1989a), in addition to any modification required as a result of Endangered Species Act consultations performed as a result of project relicensing, or license reopener processes. A full discussion of the existing mitigation measures is provided in Section 4.2.2.1 under Juvenile Migration/Survival - Rock Island Dam. It is likely that NMFS would initially require increases in spill. Unlike the other Mid-Columbia River hydroelectric projects, spilling an estimated 40 percent of the total river flow would result in exceeding the total dissolved gas water quality standard. Under these circumstances, total dissolved gas abatement structures would be needed to continue to meet the water quality criteria. Although spillway flow deflectors (the most widely used gas abatement structures in the basin) appear to increase juvenile fish mortality by 1 to 3 percent, spillway survival is expected to be greater than turbine fish passage survival (Giorgi et al. 2002). If spill was not able

to meet the necessary protection levels for the listed species, other measures necessary to aid in the protection of listed species could be stipulated, up to full mitigation for project effects.

Currently, the primary methods for maximizing juvenile spring-run chinook salmon and steelhead survival at the Rock Island Dam are through spill and predator control programs. Although the spill program under Alternative 1 is based on an annual conservation account (power revenue loss) of \$2.05 million (in 1986 dollars), this program would be modified or replaced under Alternative 2 with a program that would allow greater spill levels to avoid extinction of the listed species, if necessary.

The predator control program includes the removal of northern pikeminnow from the forebay and tailrace areas, as well as predator bird hazing and exclusion wires strung across the tailrace. Between 1995 and 2002 approximately 36,500 predatory northern pikeminnow were removed from the vicinity of Rock Island Dam under this program (West 2001, West 2002 personal communication). The predator control program is expected to result in a substantial reduction in predation rates on migrating salmon and steelhead smolts.

These protection measures are expected to increase the survival of juvenile fish passing the Rock Island Dam. Survival studies estimate survival at about 95.8 percent for steelhead and between 88.9 and 95.6 for chinook salmon (see Table 3-5).

Adult Migration/Survival

Although the combined effects of all Columbia River hydroelectric projects on the listed species is unknown at this time, many of the effects are likely cumulative. The presence of these dams results in migration delay, thereby influencing migration speed and timing of adult fish. However, the increased migration speed of adults passing though the relatively slack water

reservoirs likely results in no appreciable change to overall migration timing of returning adult fish compared to natural river conditions.

There is limited available data to assess the survival of adult anadromous salmonids passing the Mid-Columbia River projects. Radiotelemetry evaluations conducted between 1993 and 1998 provide the bulk of the available information, although survival was not specifically addressed in these studies. Although the radio-telemetry technique is problematic for addressing adult passage survival, the study results are the best available data for determining potential project-related effects.

Reservoir drawdown is a remote possibility under Alternative 2 (through the FERC relicensing process). Reservoir drawdown is expected to affect the migration rate of adult fish. Unless the dams were breached, adults would still need to pass through (modified) fishways, and there would also be a reduction in the amount of slack water habitat in the smaller reservoirs. These factors could result in an increase in the migration time and the energy expended by migrating adult salmonids. A separate EIS on drawdown effects would be necessary, if drawdown were to become a potential action alternative during relicensing, because of the potentially extensive environmental impacts associated with drawdown.

The effects of project operations on migratory bull trout are unknown, although adult bull trout have been observed using the adult fishways. Based on their presence at the project, their migratory behaviors, and recent radio-telemetry data (Stevenson and Hillman 2002), some portion of the population passes through the turbines, spillways, juvenile fish passage systems, or adult fishways, either voluntarily or involuntarily. Studies to determine whether the projects affect bull trout are underway at all three of the PUD dams. The mitigation requirements for protecting bull trout would be determined through

consultations between FERC, the PUDs, and USFWS.

Wells Dam

The protection and enhancement measures planned for adult spring-run chinook salmon and steelhead under Alternative 2 would be similar to the mitigation measures discussed previously for Alternative 1.

Specific operational procedures have been developed to minimize the effects of project operations on the passage of adult fish at the project. NMFS would assess these project facilities and operations to determine if modifications are necessary to ensure that project operations do not jeopardize the continued existence of listed anadromous fish.

There is no indication that substantial injuries are occurring to adult fish passing upstream through the fishladders under normal operating conditions. Therefore, the greatest potential for injury and mortality to adult fish is believed to be associated with fallback. Fallback rates for spring-run chinook salmon and steelhead are relatively low, with 3.6 percent fallback observed for spring-run chinook in 1993 and 6.8 percent fallback observed for summer-run steelhead in 1999 (Stuehrenberg et al. 1995; English et al. 2001). During the summer-run steelhead study, all but one of the fish that fellback over Wells Dam either reascended the dam or were detected in spawning streams downstream of the dam.

Steelhead kelt monitoring in 1999-2000 indicated that all of the radio-tagged kelts observed at Wells Dam passed through the project during the juvenile outmigration and were provided an opportunity to pass downstream of the project via a non-turbine passage route (spill and/or bypass routes). However, there was no assessment of the ultimate fate of these kelting steelhead. Similarly, no accurate fate information was available for fish that fellback over Wells Dam during the 1993 spring-run chinook study. Further investigating the potential effects of fallback on adult survival

might be a requirement established either during the relicensing process or through Endangered Species Act consultations.

Rocky Reach Dam

For the protection and enhancement of adult spring-run chinook salmon and steelhead under Alternative 2, the Chelan County PUD would maintain and operate the adult passage facility according to the existing FERC license, or as modified by Section 7 consultations conducted as a result of relicensing or reopener proceedings. Specific operational procedures have been developed to minimize the effects of project operations on the passage of adult fish at the project. NMFS would assess these project facilities and operations to determine if modifications are necessary to aid in the recovery of listed species.

At least 80 percent of the sockeye and summerrun chinook salmon passage delay apparently occurs in the fishway entrance pools, and it is likely that similar effects are responsible for spring-run chinook salmon and steelhead delay. However, there is only limited information indicating that these factors may be affecting overall spawning success. In addition, there is little data to assess the survival of adult salmon or steelhead fallbacks or steelhead kelts passing downstream (refer to Section 3.2.5, Adult Survival at Projects for more information). The assessment of adult salmonid fallback or steelhead kelt survival at the project might be a requirement established through Endangered Species Act consultations in either relicensing or reopener proceedings.

Rock Island Dam

For the protection and enhancement of adult spring-run chinook salmon and steelhead under Alternative 2, the Chelan County PUD would maintain and operate the adult passage facilities at the project according to the existing FERC license, the Rock Island Settlement Agreement, relicensing or license reopener processes, and any future Section 7 consultations. Specific

operational procedures have been developed to minimize the effects of project operations on the passage of adult fish at the project. The effects of these actions are similar to those described for the Rocky Reach Dam (refer to Section 3.2.5, Adult Survival at Projects for more information). NMFS would assess these project facilities and operations to determine if modifications are necessary to aid in the recovery of listed species.

Adult Reservoir Spawning

There is no available information indicating that substantial spawning activity of adult spring-run chinook salmon or steelhead occurs in the Wells, Rocky Reach, or Rock Island reservoirs, although some steelhead spawning might occur in tailrace areas (similar to summer/fall-run chinook salmon spawning) or at the mouths of the mainstem tributaries. As a result, the operation of the Wells, Rocky Reach, and Rock Island hydroelectric projects may have some effect on steelhead spawning success in these areas. Potential indirect effects associated with adult passage conditions at the projects are similar to those described previously for threatened and endangered species (Adult Migration/Survival).

If implemented, drawdown would increase the amount of mainstem spawning habitat, although it is unlikely to affect spring-run chinook salmon, which typically spawn in upper tributary areas. It is not clear how much this would benefit steelhead.

Although bull trout are occasionally observed in the project areas, they are generally believed to spawn in small headwater tributaries. Therefore, project operations are not expected to directly affect bull trout spawning beyond the potential migration effects that may be occurring at the dams.

Tributary Habitat Improvements

Similar to Alternative 1, the PUDs would not provide funding for habitat-related measures for adult spawning and juvenile rearing in the Mid-Columbia River tributary streams to aid in the protection and recovery of listed species under Alternative 2. However, funding from other sources might be available to improve tributary habitat.

Hatchery Production

The hatchery programs currently funded by the Chelan and Douglas County PUDs were developed to mitigate the loss of spawning habitat from the inundation of the mainstem Columbia River by the project reservoirs and estimated losses associated with fish passage at the projects. Under Alternative 2, these facilities would continue to be funded by the PUDs and operated by WDFW in accordance with policies and guidelines of the State, as well as Section 10 permits issued under the provisions of the Endangered Species Act. The Section 10 permits describe the efforts implemented to avoid and minimize adverse effects to Endangered Species Act-listed species. These efforts include protocols for adult collection and spawning, rearing and release strategies, fish health management programs, and environmental monitoring. These protocols are expected to be followed for all hatchery stocks and would equally benefit unlisted fish species. However, if NMFS determines that the current hatchery production levels are likely to jeopardize the continued existence or recovery of the listed species, the production levels could be reduced.

Hatchery production could also be reduced at project relicensing or license reopener proceedings under Alternative 2. Recent juvenile fish passage survival studies indicate that survival through the Mid-Columbia River projects is greater than initially estimated. These differences are likely the result of more accurate evaluation techniques and the fish passage improvements

that have already been implemented at the projects.

Wells Dam

Under Alternative 2, the Douglas County PUD would continue to fund the current hatchery compensation programs for spring-run chinook salmon at the Methow Fish Hatchery, for steelhead at the Wells Hatchery, and for off-site acclimation facilities according to stipulations in the 1990 Wells Settlement Agreement (FERC 1991). Operation of the Wells Hatchery has been reviewed under Section 7 of the Endangered Species Act, and a Section 10 permit (#1094) was issued to WDFW on February 4, 1998 (NMFS 1998b). However, this permit will expire in May 2003, and will be replaced with Permit #1395. Under Alternative 2, the new permit is expected to include Douglas County PUD as a joint permittee with WDFW.

Operation of the Methow Fish Hatchery was considered in the review of Section 10 Permit #1196 (to WDFW) and the biological opinion concerning NMFS's issuance of that permit (NMFS 2002c). This permit will likely be amended, or modified, within the next 12 months. The modifications are expected to include the PUD as a joint permittee. Therefore, Endangered Species Act requirements would be satisfied for the operational protocols of the PUD-funded hatchery compensation program under Alternative 2. As with Alternative 1, reduced hatchery production levels are expected to occur under Alternative 2, as is provided for in the existing settlement agreement. Additional reductions could also be implemented to protect listed species or to compensate for actual fish losses at the project.

Hatchery production established through the 1990 Wells Settlement Agreement is intended to compensate for an assumed total project mortality rate of 14 percent (including reservoir and dam passage mortality). Recent juvenile survival studies suggest that the actual losses are substantially lower than 14 percent (about 4

percent). Therefore, under the terms of the existing settlement agreement, hatchery production established to mitigate for fish passage losses at Wells Dam could be reduced by about 70 percent (from 14 to about 4 percent) under Alternative 2. Similar reductions could occur under Alternative 1.

Rocky Reach Dam

The Turtle Rock, Rocky Reach Annex, and Chelan Falls hatcheries are owned by the Chelan County PUD and operated by WDFW. They have previously been reviewed under Section 7 of the Endangered Species Act and issued a Section 10 permit (#1094) to WDFW. The Section 10 permit describes the protocol necessary for WDFW to avoid and minimize adverse effects to listed species (similar to those described previously). However, this permit will expire in May 2003, and will be replaced with Permit #1395. Under Alternative 2, the new permit would be expected to include Chelan County PUD as a joint permittee with WDFW. Therefore, Endangered Species Act requirements would be satisfied for the PUD-funded hatchery compensation program under Alternative 2.

Under Alternative 2, the Chelan County PUD would continue to fund the operation and maintenance of these hatcheries at a level equivalent to the 1996 budgeted operation and maintenance costs, adjusted annually for inflation. The existing production capacities are believed to compensate for original inundation behind Rocky Reach Dam, and more than compensate for juvenile fish passage losses (i.e., produce more juvenile salmon and steelhead each year than are killed by the projects).

The hatchery program would likely continue to be operated by WDFW in a manner consistent with the recovery of spring-run chinook salmon and steelhead populations. As a result, the Chelan County PUD is currently working with the fishery agencies and Tribes to develop a conservation and supplementation strategy instead of a strictly numerical compensation program as used in the

past. Under Alternative 2, NMFS would likely require that these programs use locally adapted broodstock to the extent possible. Similar program changes are expected to occur under Alternative 1.

Rock Island Dam

The Eastbank Hatchery Complex is owned by the Chelan County PUD and operated by WDFW. The spring-run chinook salmon program was considered in the review of Section 10 Permit #1196 (to WDFW) and a biological opinion concerning NMFS's issuance of that permit (NMFS 2002c). The Section 10 permit requirements are similar to those described previously. This permit will be amended or modified in the next 12 months, and the modifications under Alternative 2 would include adding the PUD as a joint permittee. Therefore, Endangered Species Act requirements are satisfied for the operational protocols of the PUDfunded hatchery compensation program under Alternative 2, although the allowable production levels could be reduced in the future to protect listed species.

The Chelan County PUD would continue to fund the operation and maintenance of these hatcheries at a level equivalent to the 1998 budgeted operation and maintenance costs, adjusted annually for inflation. The existing production capacities are believed to compensate for juvenile fish passage losses at Rock Island Dam.

Associated Tributaries

Potential effects associated with hatchery supplementation in the Mid-Columbia River tributaries are similar to those described under Alternative 1. These include the potential interactions between hatchery and wild stocks (competition, predation, and disease transmission) and the potential changes or alterations to the genetic integrity and diversity of both populations. Compared to Alternative 1, modifications likely to occur under Alternative 2 would reduce these negative hatchery effects and

lead to improved return per spawner ratios, benefiting the listed species.

Monitoring and Evaluation

Under Alternative 2, the PUDs would continue to implement research and monitoring to ensure that mitigation measures implemented at each of the projects are achieving the goals outlined in the existing license articles, settlement agreements, and interim stipulations. Additional research would also be required to determine the survival of both juvenile and adult spring-run chinook salmon and steelhead at the projects and through the system. In addition, evaluations to determine what effects adult passage conditions have on adult spawning success and fecundity might be required, as well as evaluations to determine the extent of kelt passage and survival and the contribution of kelts to the overall population structure of listed steelhead. Extensive water quality monitoring would be required, as would evaluations of methodologies to reduce total dissolved gas levels. Life-cycle modeling evaluations would also be conducted periodically to ensure that the species are recovering. This information is vital to the development and monitoring of long-term protection measures.

Wells Dam

Under Alternative 2, the Douglas County PUD would conduct similar monitoring and evaluation measures described under Alternative 1. Other monitoring and evaluation programs might also be required to ensure that project and system survival rates of both juvenile and adult springrun chinook salmon and steelhead are maximized to ensure the protection of listed species. Increased water quality monitoring might also be required to ensure that the project is operating with as little impact as possible.

Although the effectiveness of the existing mitigation measures for juvenile fish appears to be high (total project survival is estimated near 97 percent for all anadromous species), survival estimates would need to be verified over the long

term. Uncertainties regarding adult survival estimates based on radio-telemetry studies indicate that new survival assessment techniques need to be developed for this life stage. As new technologies are developed, Douglas County PUD might be required to evaluate project effects on adult steelhead and spring-run chinook salmon. The Douglas County PUD might also be required to participate in periodic run stock assessment modeling efforts to document the status of listed species found in project waters.

Rocky Reach Dam

Under Alternative 2, the Chelan County PUD would continue to conduct monitoring and evaluation measures similar to those described under Alternative 1, in addition to efforts similar to those described for the Wells Dam under Alternative 2.

Rock Island Dam

Under Alternative 2, the Chelan County PUD would continue to conduct monitoring and evaluation measures similar to those described under Alternative 1, and additional efforts similar to those described for the Wells Dam under Alternative 2.

4.2.2.2 Other Anadromous Salmonid Species

Similar to Alternative 1, the criteria for protecting unlisted species under Alternative 2 are based primarily on project operational guidelines outlined in the existing FERC licenses and settlement agreements rather than survival criteria.

Compared to Alternative 1, the spring migrating, unlisted anadromous salmonid species (juvenile sockeye and coho salmon) are generally expected to benefit from the protection measures instituted under Alternative 2 for the listed species due to the overlap in both migration timing and habitat utilization. Alternatives 1 and 2 are likely to provide equivalent protection levels for summer

migrating species (juvenile summer/fall-run chinook salmon).

Drawdown would have similar effects on the unlisted species, as described previously for the Endangered Species Act-listed species. However, summer/fall-run chinook salmon are primarily mainstem-spawning fish, so the increased spawning habitat resulting from reservoir drawdown is expected to benefit them to a greater degree.

Juvenile Migration/Survival

Wells Dam

There would be no additional measures for unlisted species implemented at the Wells Dam under Alternative 2, beyond what is currently required under the existing FERC license and settlement agreement. However, some unlisted species could benefit from any additional measures implemented for listed species, especially for those species that have similar run timing or use common habitat. For example, juvenile protection measures that may be required for spring-run chinook salmon and steelhead would likely benefit sockeye and coho salmon as well.

Currently, the Wells juvenile bypass system has an average fish passage efficiency of 92 percent for all spring migrants, and 96 percent for all summer migrants (Skalski 1993). The overall survival rates for the unlisted anadromous species are expected to be similar to those discussed above for the listed species.

Yearling chinook survival at Wells Dam is expected to be similar to the 99.7 percent survival rate measured during a juvenile project survival study conducted in 1998. No estimates of juvenile project survival are available for sockeye or subyearling chinook salmon, and, as such, the calculated estimates of dam passage survival for those species are currently the best estimates of survival available for Wells Dam.

Rocky Reach Dam

There would be no additional measures for unlisted species implemented at the Rocky Reach Dam under Alternative 2, beyond what is currently required under the existing FERC license or future relicensing or license reopener proceedings. However, unlisted species are expected to benefit from some of the measures implemented for listed species, especially those species that have similar migration timing. For example, unlisted juvenile sockeye and coho salmon typically migrate through the Columbia River at the same time as listed juvenile springrun chinook salmon and steelhead. These potential benefits are similar to those listed above for the Wells Dam.

The main goal of the juvenile fish mitigation measures at the Rocky Reach Dam for unlisted species is to develop a safe (less than 2 percent mortality) bypass system. Based on available information, estimates of juvenile survival range from 94.8 to 97.0 percent for unlisted anadromous salmonid species (see Table 4-2). These survival rates are comparable to the 95 percent juvenile dam passage survival goal established for Endangered Species Act-listed species in the HCP (Alternative 3). They are also based on spilling 40 percent of the total river flow over 99 percent of the spring and summer juvenile migration period.

In the event that the bypass does not meet required survival standards, Alternative 2 includes a 6,000-cfs sluiceway that would draw water and fish from the forebay at the downstream end of the cul-de-sac. This bypass option is discussed in greater detail in Section 4.2.2.1, Endangered Anadromous Salmonid Species, for the listed species.

For comparison purposes, it is assumed that similar protection measures would be provided to both the listed and the unlisted species under Alternative 2. However, greater protection measures could actually be required for the listed species than for the unlisted species, because of

the greater authority provided by the Endangered Species Act compared to the Federal Power Act. As a result, some plan protection measures that might be beneficial to the listed species may be detrimental to others. For example, turbine intake screens would likely improve the survival rate of spring-run chinook salmon and steelhead but present a substantial impingement and descaling hazard to sockeye and subyearling fall-run chinook salmon. Such conflicting measures are less likely to occur under Alternative 1, because no greater protection measures would be provided for listed species under Alternative 1.

Additional protection measures for unlisted species might also be provided during the relicensing process currently underway for Rocky Reach Dam.

Rock Island Dam

The protection measures implemented at the Rock Island Dam under Alternative 2 would follow the requirements of the existing FERC license and settlement agreement or license reopener proceedings. Although the primary focus of the alternative would be to protect the listed species, similar to the Wells and Rocky Reach dams, unlisted species are expected to benefit from some of the measures implemented for listed species.

The primary method for maximizing juvenile anadromous fish survival at the Rock Island Dam is through spill. For comparison purposes, it is assumed that up to 40 percent of the total river flow would be spilled throughout 99 percent of the spring and summer juvenile migration periods under Alternative 2.

Similar to the juvenile fish mitigation measures for unlisted species described for Rocky Reach Dam, the protection programs at Rock Island Dam would most likely be prescriptive, and may not include survival goals. For the purposes of comparing alternatives, expected survival under Alternative 2 can be estimated by combining passage-route survival data (see Table 4-3).

However, due to the number of uncertainties related to these calculated survival estimates, the estimates are only used to compare alternatives or specific components within alternatives.

Based on available information, juvenile survival for the unlisted anadromous salmonid species passing the Rock Island Dam are expected to range from 94.8 to 96.7 percent for sockeye salmon and fall-run chinook salmon (see Table 4-3). These survival rates are comparable to the 95 percent juvenile dam passage survival goal established for Endangered Species Act-listed species in the HCP (Alternative 3). They are also based on spilling 40 percent of the total river flow over 99 percent of the spring and summer juvenile migration period.

Adult Migration/Survival

Results from several radio-tag studies have indicated that the adult fishways at the Mid-Columbia River dams are generally effective at providing passage for anadromous adult fish, although passage times for summer/fall-run chinook salmon appear to be longer than for spring-run chinook salmon and steelhead (see Table 2-4). Summer/fall-run chinook salmon are also likely to be more vulnerable to delays because their migrations extend longer into the summer, when water temperatures are higher. Higher temperatures increase metabolic rates and result in greater energy expenditures by migrating fish. Their migration period also tends to be closer to their spawning periods, allowing less time to compensate for migration delays. Although these factors might be increasing the rate of pre-spawning mortality for some of the anadromous species, there are no data to verify or quantify the effects.

Under Alternative 2, the adult fishways at the PUD projects would be operated according to the same criteria as described under Alternative 1. Potential improvements identified as a result of evaluations conducted for listed species are also expected to benefit the unlisted species.

Reductions in adult mortality and fallback, as well as the protection of downstream migrating steelhead kelts (post-spawning adults), would be factored into the design and operation of any juvenile bypass systems, adult passage facilities, and project operation protocols.

Wells Dam

Radio-telemetry evaluations at the Wells Dam indicate that summer/fall-run chinook salmon experienced passage delays negotiating the collection channel and entering the ladder (see Table 2-4). However, recent modifications to ladder operations have indicated a substantial reduction in the passage times of adult summer/fall-run chinook salmon. Closing the side entrances to the ladder resulted in passage time reductions from 52.5 to 20.6 hours in 1997 and from 38.5 to 19.0 hours in 1998. There are no indications that sockeye salmon experience substantial delays passing the project. Although there are no known direct sources of mortality to adult salmonids at Wells Dam under normal operating conditions, mortality could occur as a result of fallback. However, the magnitude of the effects is unknown.

Under Alternative 2, the Douglas County PUD would maintain and operate adult passage facilities in accordance with the existing FERC license and the 1990 Wells Settlement Agreement (FERC 1991). Adult fish passage facilities would also be subject to measures resulting from relicensing, license reopener processes, or Endangered Species Act consultations. The Douglas County PUD would also continue to operate spill and turbine units in a manner that accommodates adult passage, while meeting requirements for juvenile fish passage. The implementation of these adult fish passage operations would be expected to minimize the effects on adult fish passing the project. These operational parameters would be implemented under Alternative 1 as well.

Rocky Reach Dam

Under Alternative 2, the Chelan County PUD would maintain and operate adult passage facilities in accordance with the existing FERC license, as well as any future protocols established during relicensing, license reopener processes, and corresponding Endangered Species Act consultations. There is evidence at Rocky Reach Dam to suggest that sockeye and summerrun chinook salmon experience passage delays in the fishway entrance pools at Rocky Reach Dam. However, there are no data to suggest any direct injury or mortality resulting from fish passage under normal operating conditions.

Rock Island Dam

Under Alternative 2, the Chelan County PUD would maintain and operate adult passage facilities in accordance with the existing FERC license and settlement agreement, as well as any future protocols established during relicensing, license reopener processes, or Endangered Species Act

consultations. The potential problems associated with passage through these fishways are attributed to delays in locating the entrances, and in the junction pools. However, the available data suggest that passage conditions at Rock Island are better than at Rocky Reach or Wells dams (see Table 2-4).

Adult Reservoir Spawning

No direct effects of project operations on coho or sockeye salmon spawning are expected under Alternative 2 because they spawn well upstream of the projects in tributary streams. Summer/fall-run chinook salmon is the one species that is expected to exhibit substantial spawning activity in the Mid-Columbia River reservoirs. However, their spawning habitat is primarily restricted to upper reservoir or tailrace areas (see Section 4.2.2.2, Other Anadromous Salmonid Species). Project operations related to adult passage of unlisted species is expected to be similar to Alternative 1.

Hatchery Production

As discussed previously, the hatcheries funded by the Chelan and Douglas County PUDs are operated by WDFW in accordance with policies and guidelines of the State and Section 10 permits issued under the provisions of the Endangered Species Act. Hatchery operations for unlisted species under Alternative 2 are expected to be similar to those described for Alternative 1 (see Section 4.2.2.1, Endangered Anadromous Salmonid Species).

<u>Tributary Habitat Improvements and Monitoring</u>

Under Alternative 2, the PUDs would not provide funding for off-site habitat improvements. The previous discussions of tributary habitat improvements and monitoring programs related to the Endangered Species Act-listed stocks are also expected to be applicable to the unlisted species under Alternative 2 (see Section 4.2.2.1, Endangered Anadromous Salmonid Species).

4.2.2.3 Resident Fish Species

Project Areas

The potential effects of project operations on resident fish under Alternative 2 are the same as those discussed previously for Alternative 1 (see Section 4.2.1.3, Resident Fish Species), with the possible exception of Pacific lamprey. As discussed previously, the potential increased use of turbine intake screens to improve the juvenile dam passage survival rates for listed species would increase the potential effects to Pacific lamprey migrating past the projects because of their susceptibility to injury or impingement on intake screens. Although the potential use of intake screens under Alternative 2 has not been determined, additional screens are unlikely to provide substantial benefits at Wells or Rocky Reach dams, but could be used to increase bypass efficiency at Rock Island Dam.

Other project modifications designed to increase juvenile salmonid bypass survival are not expected to substantially benefit or affect lamprey because their vertical spatial distribution tends to be deeper than juvenile salmonids (Hatch and Parker 1996). Such modifications are also not expected to substantially change the effect on other resident fish species under Alternative 2 compared to the existing conditions, because the purpose of the modifications is to improve fish passage survival at the projects. Fish that do not encounter the bypass modification structure would pass the projects in a manner similar to under Alternative 1.

Associated Tributaries

Project operations under Alternative 2 would not alter tributary habitat or resident fish populations that occur there. However, migratory species that move between the tributary and reservoir areas might be affected by project operations, as discussed previously. These effects are not expected to be substantially different from existing conditions (Alternative 1).

4.2.3 ALTERNATIVE 3

The HCPs represent long-term protection, mitigation, and enhancement plans for all Plan species to aid in the recovery of Endangered Species Act-listed species (see Section 2.4.3.1, HCP Species). The HCPs include provisions to minimize the direct effects of project operations on fish species and aquatic resources, as well as provisions for hatchery funding and tributary habitat restoration activities. These latter features are intended to compensate for unavoidable effects that cannot be mitigated or eliminated as part of project operations or improvements made to project structures. The overall objective is to achieve no net impact to each of the Plan species through the establishment of a 91 percent combined adult and juvenile survival goal for listed and unlisted Plan species. The 9 percent unavoidable mortality would be mitigated

through hatchery and tributary enhancement programs.

The HCPs are intended to be consistent with basinwide efforts to protect salmonids that originate upstream of the Mid-Columbia River hydroelectric projects. The focus of the HCPs is to establish a cooperative planning and implementation process to achieve specific survival standards for all anadromous salmonid species, regardless of their Endangered Species Act listing status. This effort would include the participation of State and Federal fishery agencies and local Native American Indian Tribes who sign the HCP agreements. Under Alternative 1, salmonid protection measures would likely address on-site, project-specific issues on a caseby-case basis. Decisions would continue to be made by the existing coordinating committees, and there would be no specific planning strategy to recover the listed species.

4.2.3.1 Endangered Anadromous Salmonid Species

The effects of the operation of the Mid-Columbia River projects were assessed in the draft Quantitative Analysis Report (QAR). A summary of the draft QAR is provided in Appendix E. The draft report summarizes available information for Endangered Species Act-listed Upper Columbia River steelhead and spring-run chinook salmon, reviews alternative approaches to estimating the risks of extinction and recovery perspectives, and provides preliminary estimates of the relative risks of extinction under a range of alternative management and climate and environmental scenarios.

The survival standards established in the HCPs were initially developed through negotiations between State and Federal resource agency and PUD biologists. The QAR process, which was developed with the support and participation of each of these groups, determined that implementing the HCP standards (at all five Mid-

Columbia River PUD projects) would increase juvenile survival by between 116 and 135 percent of the recent survival levels (1982 to 1996 juvenile passage years). In addition, implementation of the proposed Tributary Conservation Plan would further increase survival to a total of between 123 and 149 percent of the recent survival levels.

Under Alternative 3, the HCP coordinating committees would direct the PUDs in the use of a variety of protective measures to reach the survival standards. These measures could be used independently or in any combination to achieve the performance standards for each Plan species, including the listed spring-run chinook salmon and steelhead species. In comparison, the protective measures implemented through the Endangered Species Act consultations under Alternative 2 would be implemented to maximize the survival of only listed species, while the protection of unlisted species would be provided through existing FERC licenses, settlement agreements and future license reopener or relicensing processes (similar to Alternative 1).

The Alternative 3 protection measures would apply to all Plan species. Under Alternative 2, protection measures would be implemented primarily for the listed species, although the unlisted species might coincidentally benefit from some of the measures. No new protection measures would be implemented under Alternative 1. Therefore, NMFS is less likely to achieve protective measures for unlisted species that are comparable to Alternative 3. Under Alternative 3, the HCP tributary habitat conservation programs would be initiated within 90 days after FERC approval. Therefore, the overall protection and recovery potential of the listed species is expected to be similar or better under Alternative 3 compared to Alternative 2, while the protection measures for unlisted species would likely be greater under Alternative 3 than either Alternative 1 or Alternative 2 (see Table 2-8).

As discussed, bull trout are not included as a Plan species. Therefore, the survival standards established in the HCPs do not apply to bull trout. FERC has initiated informal consultations with the PUDs and USFWS under Section 7 of the Endangered Species Act to begin evaluating the effects of project operations on bull trout. Protection of bull trout would be the same for all EIS alternatives.

Juvenile Migration/Survival

Given the present inability to differentiate between the sources of adult mortality, initial compliance with the combined adult and juvenile survival standard would be based upon the measurement of juvenile project survival. The juvenile fish passage survival standard is to achieve 93 percent juvenile project passage survival through the project areas, including direct and indirect mortality, wherever it occurs (see Section 4.1.2 of the Wells HCP and Section 5.2.2 of the Rocky Reach and Rock Island HCPs – 93% Juvenile Project Survival and 95% Juvenile Dam Passage Survival).

Wells Dam

Juvenile salmonid survival studies at Wells Dam indicate total project survival estimates of 99.7 percent for hatchery-reared juvenile spring-run chinook salmon (Bickford et al. 1999) and 94.3 to 94.6 percent for hatchery-reared steelhead smolts (Bickford et al. 2000a, 2001) under existing conditions (see Table 3-4). If the Wells bypass system is equally beneficial for all Plan species, there would be no additional requirements over the next 50 years to increase dam passage survival unless juvenile project passage survival fell below 93 percent in the future. Verification of survival rates would occur every 10 years, using representative (surrogate) spring-migrating and summer-migrating species.

Adjustments to the compensation levels, as a result of the survival studies, would occur under all HCP Phases, although compensation for initial inundation of the projects would not be adjusted.

The completed survival studies show that the dam passage survival standards are being exceeded at Wells Dam, so existing hatchery programs compensating for project passage mortality could be reduced. The Douglas County PUD is expected to reduce the existing 14 percent compensation level to 3.8 percent for yearling chinook salmon and steelhead, based on survival studies that indicated an average survival of 96.2 percent. Similar reductions are expected for Alternatives 1 and 2.

The predator control programs would continue to be implemented and are expected to benefit all Plan species, bull trout, and other non-predator resident species.

Rocky Reach Dam

Programs for the protection and enhancement of spring-run chinook salmon and steelhead under Alternative 3 would be based on the same performance standards as those described for Wells Dam. Although project operations under Alternative 3 would be similar to those outlined for Alternative 2, the effectiveness of these operations would be evaluated and modified, with the requirement of making continual progress toward achieving no net impact.

Recent PIT-tag and radio-tag evaluations on hatchery-reared and run-of-the-river steelhead smolts indicate project passage survival estimates of between 95.9 and 96.7 percent (Bickford et al. 2000b, 2001; Stevenson et al. 2000) (see Table 3-4). These studies indicate that steelhead are likely meeting the HCP survival standards (Phase III – Standard Achieved). However, as discussed earlier, the single-release evaluation method does not include all the factors that could influence survival, and the radio-telemetry method has not been fully evaluated (see Section 4.2.1.1, Endangered Anadromous Salmonid Species). As a result, additional evaluations would be required to evaluate juvenile passage survival at Rocky Reach Dam before a determination can be made about meeting the HCP survival standards. Survival would be reevaluated every 10 years

using representative spring- and summermigrating species.

In contrast to steelhead, survival studies using hatchery chinook salmon indicate juvenile project passage survival at between 85.9 and 93.9 percent, for an average of 89.9 percent (Eppard et al. 1999; Bickford et al. 1999). However, the 93.9 percent estimate is from single-release PIT-tag evaluations, and therefore might overestimate the actual juvenile fish project passage survival rate (see Section 4.2.1.1, Endangered Anadromous Salmonid Species; Rocky Reach Dam).

If the survival estimates generated from Phase I testing (2004 to 2006) indicate that the pertinent survival standards are not being achieved, then Chelan County PUD would move to Phase II (Additional Tools). In this phase, the Rocky Reach HCP Coordinating Committee would decide on the additional tools for the PUD to implement in an effort to reach the survival standard. By comparison, under Alternative 2, NMFS would be primarily responsible for ensuring that listed species were being adequately protected, while the Mid-Columbia Coordinating Committee would likely determine appropriate measures for unlisted species. If the Phase I survival studies indicate that the standards have been achieved for a given species, then the PUD would move to Phase III for that species.

Phase III indicates that the appropriate standard has either been achieved or is likely to have been achieved and provides additional or periodic monitoring to ensure that survival of the Plan species remains in compliance with the HCP survival standards. Under Phase III, the HCP coordinating committees would determine which representative species (one for spring migrants and one for summer migrants) would be tested in each subsequent 10-year interval (see Wells HCP Section 4.2.5.1 and Rocky Reach and Rock Island HCPs Section 5.3.3 – Phase III).

If necessary, improving juvenile dam passage survival might be accomplished through additional modifications to the bypass system. However, increasing the proportion of fish passing through the surface collection system would be increasingly more difficult due to the limited number of fish that are available for passage at this location. This limitation is due to the configuration of the dam that creates a cul-desac on the powerhouse side of the forebay. Fish migrating down the other side of the river would not enter the area influenced by the attraction flow of the collector until they had avoided passing the project through the spillway and most of the turbine units. It is also important to note that increasing the efficiency of one aspect of the collector may result in a decrease in the efficiency of another aspect due to the finite number of fish in the cul-de-sac area. Alternative 1 does not include specific survival goals, thus fewer bypass modifications would be expected. Bypass modifications under Alternative 2 would target survival improvements for listed species.

Installing additional turbine intake screens to provide greater protection to the listed species at Rocky Reach Dam is also problematic because of the potential injury and impingement rates to other species, such as sockeye salmon, subyearling chinook salmon, and lamprey. In addition, the number of fish that pass through the higher numbered turbines (currently unscreened) is substantially lower than the units that currently have screens.

Because of the potential limitations related to increasing fish passage through the surface bypass system, spill might continue to be a component of the juvenile passage system at the Rocky Reach Dam during the HCP term. However, the use of spill may be limited by water quality standards for total dissolved gas (see Section 3.3.2, Water Quality). This might require the implementation of a total dissolved gas abatement program.

Rock Island Dam

Performance standards for juvenile fish passage at the Rock Island Dam are the same as those described for the Wells and Rocky Reach dams. Although project operations under Alternative 3 would be similar to those for the listed species under Alternative 2, the effectiveness of these operations would be evaluated and modified, with the goal of making continual progress toward achieving no net impact to all the Plan species.

PIT-tag and radio-tag evaluations at Rock Island Dam indicate that juvenile project passage survival for chinook salmon is between 88.9 and 94.7 percent (average of 92.3 percent). If this were still the case after HCP Phase I evaluations (2002 to 2004), Chelan County PUD would move to Phase II (Additional Tools). In this phase, the Rock Island HCP Coordinating Committee would decide on the additional tools for the PUD to implement in an effort to reach the survival standard. In comparison, under Alternative 2, NMFS would have the primary role in determining the appropriate measures for listed species, although coordination with the Rock Island Coordinating Committee would likely occur.

Juvenile steelhead survival studies indicate a project survival rate of between 92.0 and 99.8 percent (95.9 percent arithmetic mean) (Stevenson et al. 2000; Skalski et al. 2001). If this were still the case after HCP Phase I evaluations (2002 to 2004), Chelan County PUD would move to Phase III (Standard Achieved) for steelhead. In this phase, no additional juvenile passage measures would be required over the term of the HCP, unless future survival studies indicate a survival rate less than 93 percent. Survival rates would be verified every 10 years under Phase III (Standard Achieved), using species representative of spring and summer migrants. The representative species for each migration period would be determined by the HCP coordinating committees.

Survival evaluations for each of the Plan species would occur during Phase I testing, under varying environmental conditions and over successive outmigrations. Based on these evaluations, each Plan species would be assigned a phase category. As a result, different phase determinations could be in effect at the same time for different species. Under Alternative 1, survival studies would likely be limited to spillway survival assessments because spill is the primary fish bypass option at Rock Island Dam. Although spill is also likely to be the primary bypass option under Alternative 2, survival studies would likely occur for the listed species to verify the effectiveness of the spill program.

The assumed reliance on spillway passage to achieve the juvenile dam passage survival standards might be limited by the generation of high downstream total dissolved gas levels as a result of spilling water at the project. Although the possible addition of spillway flow deflectors or other gas abatement features would likely minimize total dissolved gas production, some flow deflectors appear to increase juvenile fish passage mortality by 1 to 3 percent compared to standard spill bays (Giorgi et al. 2002).

Although the use of turbine intake screens is a potentially viable measure for implementation at Powerhouse 1, the potential impingement and injury rates to some of the other Plan species, and to other resident species, are expected to minimize their use under all the EIS alternatives.

Adult Migration/Survival

The protection measures planned for improving adult migration and survival for spring-run chinook salmon and steelhead under Alternative 3 are similar for all the alternatives, as discussed under Alternative 2 (see Section 4.2.2.1 under Adult Migration/Survival).

In addition to the protocols discussed under Alternative 2, under Alternative 3 the PUDs would emphasize adult project passage measures to ensure achievement of the 91 percent combined adult and juvenile project survival goal for each Plan species. The PUDs would also modify areas of the adult fish passage system that are identified as consistently failing to meet the HCP Adult Fish Passage Plan for Wells Dam, the Detailed Fishway Operating Plan for Rocky Reach and Rock Island dams, or other standards subsequently established by the HCP coordinating committees. Modifications would likely be made where substantial delays occur, as well as to minimize or eliminate identified sources of adult injury or mortality.

Although the inclusion of the no net impact standard in the HCP under Alternative 3 incorporates adult survival into the overall 91 percent project survival standards, accurate adult survival information is not obtainable with existing technology. As a result, there are no specific plans to assess overall adult survival at the projects under Alternative 3 (or the other EIS alternatives) until accurate assessment procedures are available. Although radio-telemetry methodologies are the best procedures to assess adult passage conditions at hydroelectric projects, they have proven problematic for assessing survival.

The effects of water temperature, passage delays, and fallback can indirectly affect spawning success. Adult spring-run chinook salmon and steelhead do not feed during their upstream migration, so they must expend considerable energy reserves for migrating and sexual development. Therefore, migration delays resulting from project passage can result in additional energy expenditures that might result in a potential for increased pre-spawning mortality or reduced spawning success. Although the effects of a single project are not likely to be substantial, the cumulative effects of multiple projects could have a measurable effect. As discussed earlier, however, adult spring-run chinook salmon and steelhead enter the Mid-Columbia River several months before spawning,

which reduces the potential effects of passage delays on spawning success.

Adult Reservoir Spawning

There is no available information indicating that substantial spawning activity of adult spring-run chinook salmon or steelhead occurs in the Wells, Rocky Reach, or Rock Island reservoirs, although some steelhead spawning might occur in tailrace areas (similar to summer/fall-run chinook salmon) or at the mouths of the mainstem tributaries. As a result, the operation of the Wells, Rocky Reach, and Rock Island hydroelectric projects may have some limited effect on steelhead spawning. Any effects would be similar for all three EIS alternatives.

If implemented under Alternative 2 or 3, drawdown would increase the amount of mainstem spawning habitat, although this would likely not affect spring-run chinook salmon spawning. It is not clear how much this would benefit steelhead. Drawdown is not included as an option under Alternative 1.

Although bull trout are occasionally observed in the project areas, they are generally believed to spawn in small headwater tributaries. Therefore, project operations are not expected to directly affect bull trout spawning beyond the effects on migration that may be occurring at the dams.

Hatchery Production

No specific facility changes are proposed for hatchery production under Alternative 3. The operation of the hatchery facilities being funded by the PUDs has either been previously addressed or would be addressed in separate biological opinions and corresponding Section 10 permits. However, any new Section 10 permits would include the PUDs as joint permittees with WDFW.

Hatchery production is based on initial inundation of fish habitat by the projects and ongoing fish

losses from project operations. Under the existing FERC licenses and settlement agreements, assumptions were made concerning ongoing fish losses at the projects. If the HCPs were implemented, supplementation levels would be set at a maximum of 7 percent, in addition to the levels established to mitigate for project inundation.

Under the HCPs, hatchery production to compensate for project passage losses would decrease for some species compared to existing production levels (Table 4-4). These decreases are because the production levels stipulated in the existing licenses and settlement agreements for project passage losses exceed the maximum 7 percent HCP level. The existing hatchery compensation level for fish passage losses at Wells Dam was assumed to be 14 percent, while the HCP compensation level is 7 percent, and would be further reduced to 3.8 percent, based on project survival studies that measured the average juvenile project passage survival rate at 96.2 percent (see Table 3-5). Therefore, compensation for passage losses provided for the Wells Project would decrease by about 70 percent compared to existing conditions. A similar reduction is also expected under Alternatives 1 and 2 because the existing settlement agreement allows hatchery production to be adjusted based on actual fish passage losses. However, additional hatchery reductions could occur under Alternative 2 if NMFS determines that the existing production levels are likely to jeopardize the continued existence of the listed species (see Section 3.2.4.4, Interaction Between Hatchery Stocks and Wild Stocks). Under Alternative 3, the initial hatchery production levels would remain unchanged until 2013.

Although the existing production levels for the Chelan County PUD projects are also believed to be greater than the actual fish passage losses, the PUD has agreed to continue funding existing hatchery production levels until 2013. At that time, adjustments can be made based on actual losses measured at the projects, or concerns about

Table 4-4. Changes in Hatchery Production Funded by the Mid-Columbia River PUDs for Project Impacts to Anadromous Fish Species under Terms of the HCPs

CURRENT HATCHERY PRODUCTION¹ **INUNDATION AND PASSAGE** TOTAL **INUNDATION AND CURRENT INUNDATION** Loss **HCP CAPACITY ADJUSTED HCP PROJECT** SPECIES **PRODUCTION PRODUCTION PRODUCTION OBLIGATION**² PRODUCTION³ Wells Summer Steelhead 300,000 180,000 480,000 390,000 348,858 Summer Chinook 804.000 400.000 1.204.000 1.004.000 912.570 Spring Chinook4 337.500⁴ 286.071⁴ 0 450,000 450,000 Fall Chinook⁵ 0 100,000 100,000 0 0 **Rocky Reach** Summer Steelhead 165,000 35,000 200,000 195,000 200,000 Summer/Fall Chinook 1,620,000 400,000 2,020,000 1,820,000 2,020,000 Spring Chinook 144,000 144,000 90.000^{5} 144,000 0 0^6 Sockeye⁶ 0 0 0 300.000 **Rock Island** Summer Steelhead 0 200,000 200,000 51.275 200.000 Summer/Fall Chinook 0 1,640,000 1,640,000 541,385 1,640,000 Spring Chinook 0 816,000 816,000 298,853 816,000 Sockeye 0 200,000 200,000 571,040 200,000 **Total PUD Production** 5.599.053⁴ $6.767.499^4$ Plan Species 2.889.000 4.565.000 7.454.000

¹ Hatchery compensation is typically specified as pounds of fish of various sizes; the production numbers (fish) included in this table were developed by dividing the specified pounds of fish to be produced by the specified fish sizes.

² Assumes the maximum compensation level for unavoidable project passage losses (7%) under the HCPs.

³ Agreed-upon production levels through 2013 under Alternative 3 for original inundation and unavoidable project mortality. Except for Wells (where the levels are adjusted for the estimated 3.8% fish passage mortality rate), these levels include compensation that exceeds the production levels estimated to mitigate for 7% unavoidable project mortality. These amounts are subject to recalculation every 10 years beginning in 2013.

⁴ Includes 225,000 spring-run chinook salmon raised in place of the Douglas County sockeye salmon obligation. This obligation will phase out in 2005.

⁵ Voluntary program (outside of FERC license or settlement agreement). WDFW voluntarily terminated this program in 2002.

⁶ HCP Rocky Reach Hatchery Committee would determine the appropriate option for providing this mitigation.

the effects of the hatchery programs on the listed species. Production levels can also be adjusted every 10 years after 2013, as appropriate.

The hatchery facilities that were developed to compensate for ongoing fish passage losses at the Mid-Columbia River projects are the Methow and Wells hatcheries for Wells Dam: the Eastbank Hatchery for the Rock Island Dam; and Turtle Rock, Rocky Reach Annex, and Chelan Hatchery for the Rocky Reach Dam. Although production levels would change for the Wells Project as a result of project survival studies, production at the Rock Island and Rocky Reach facilities would not be affected by survival study results until at least 2013. If the mortality rate for a particular Plan species is estimated at less than these initial levels in the future, the hatchery supplementation for fish passage losses can be reduced, such that no net impact is maintained.

Although no specific modifications to the hatcheries were identified in the HCPs, there is the potential that hatchery operations could be altered. These potential alterations are likely to be the result of requirements under the independent Section 10 permits (see Alternative 2). However, there are no substantive differences between the hatchery programs under any of the EIS alternatives.

Tributary Habitat Improvements

The tributary habitat improvement projects conducted under Alternative 3 would be funded through the PUD contributions made to a Plan Species Account. The initial PUD contributions to the fund would be based on compensation for 2 percent unavoidable fish passage mortality. Along with the combined adult and juvenile project passage survival rate goal of 91 percent and the 7 percent hatchery compensation rate, the total compensation would result in no net impact to all Plan species.

The funds provided to the Plan Species Account would supplement funding from other

conservation plans or programs to preserve, enhance, or restore fish habitat and water quality within the region. Whenever feasible, the tributary committees would coordinate with other programs to establish a cost-sharing process, seek matching funds, and piggyback programs onto other habitat improvement efforts. Tributary habitat improvement measures would be selected based on biological soundness and cost efficiency, and ultimately decided upon by the tributary committees. The selection criteria include concepts for providing increased spawning and rearing habitat for critical populations not adequately mitigated by other measures, or improving survival rates during critical life stages or time periods. Because the HCPs are multi-species plans, the biological requirements of all the Plan species would be included in the decision-making process. Therefore, the tributary improvement activities are expected to be beneficial to all Plan species, although all species are unlikely to benefit equally from each individual habitat improvement project recommended by the tributary committees.

Tributary habitat conservation and restoration efforts conducted under Alternative 3 would place the highest priority on maintaining and improving stream channel diversity and floodplain function. The principal means of meeting this objective is to conserve and protect riparian habitat. Such measures are expected to result in an overall improvement in incubation and rearing conditions for all fish species that occur in the tributary streams. The protection and enhancement of riparian habitat is expected to decrease bank erosion, sedimentation, and scouring of channel substrate and improve water quality in the tributary stream areas. These efforts are expected to result in increased natural production levels for both anadromous and resident fish species.

Habitat conservation and restoration measures that would increase the natural production of anadromous fish species (as well as bull trout) would include but not be limited to:

- providing access to currently blocked stream sections or oxbows,
- removing or modifying irrigation/diversion dams or other passage barriers on tributary streams,
- improving or increasing the hiding and resting cover habitat that is essential for these species during their relatively long holding period, and
- improving instream flow conditions by correcting problematic water diversion or withdrawal structures.

Such tributary habitat conservation and restoration measures are expected to improve the migration conditions for all anadromous or migratory fish species and increase the opportunities for successful spawning. Considering the current habitat conditions in the tributary streams, habitat improvement projects are expected to have a net benefit to most fish species and other aquatic organisms, because the HCP tributary committees are expected to select projects based on sound ecological principles.

Monitoring and Evaluation

Monitoring efforts for all Plan species under Alternative 3 are similar to those described for threatened and endangered species under Alternative 2. These studies would make substantial contributions to:

- quantify the effects of project operations on all the Plan species,
- provide guidance to make appropriate structural and operational modifications at the projects to adequately protect these species, and
- assess the adequacy of the hatchery compensation levels at maintaining no net impact on the Plan species.

There are no specific research and monitoring requirements under Alternative 3 beyond ensuring that the standards have been met. As an example, there are no additional water quality monitoring efforts required under the HCPs (e.g., total dissolved gas, temperature, or gas bubble disease monitoring), nor are there specific requirements to evaluate juvenile fish passage efficiency, run timing, or adult passage rates. These monitoring requirements are covered under existing licenses or settlement agreements, if applicable.

Although this monitoring would be outside the provisions provided for in the HCP, Ecology may require water quality monitoring in addition to the requirements under existing licenses, settlement agreements, and the HCPs. Additional monitoring could also be required as a result of project relicensing procedures. Although the HCPs do not require the verification of the actual compensation provided by the habitat improvements associated with the Plan Species Account, the PUDs would provide additional funding for a Tributary Assessment Program. This assessment program is funded separately from the Plan Species Account and would evaluate the relative benefits of different types of habitat enhancement projects funded by the Plan Species Account. The Tributary Assessment Fund is intended to ensure that appropriate projects are being funded.

With the exception of the monitoring programs funded by this Tributary Assessment Fund and the verification of fish passage survival levels, monitoring programs are expected to be similar for all three alternatives.

4.2.3.2 Other Anadromous Salmonid Species

Summer/fall-run chinook and sockeye salmon are also included as Plan species in the HCPs. Mid-Columbia River coho salmon are considered extinct, and would therefore not be protected under the Endangered Species Act statutes but are included as an HCP Plan species (see Table 2-7). There are some residual coho salmon populations in the Mid-Columbia River as a result of prior and current hatchery programs and as a result of straying from the Lower Columbia River coho populations. BPA is currently funding a study to assess the feasibility of reintroducing coho salmon to the Mid-Columbia River (BPA 1999).

These three unlisted Plan species are expected to benefit from improvements in juvenile and adult fish passage facilities developed for the threatened and endangered species under both action alternatives, as well as tributary habitat improvement programs implemented under Alternative 3, because their habitat requirements and fish passage characteristics tend to overlap with those of the two listed species. Alternative 3 also applies the same survival rate performance standards for these Plan species as for the endangered species discussed previously. As a result, the HCP coordinating committees are not expected to select mitigations that adversely affect any of the Plan species.

Juvenile Migration/Survival

There are limited data concerning specific project effects on passage survival for each individual anadromous fish species. Although data collected on one anadromous fish species can be used as a general surrogate for the other species, project-specific survival assessments for each Plan species are required to satisfy the HCP requirements, unless otherwise agreed to by the HCP coordinating committees.

The juvenile fish passage survival standards and the proposed protection programs for the three unlisted Plan species are the same as those described for the threatened and endangered species under Alternative 3 (see Section 4.2.3.1, Endangered Anadromous Salmonid Species). Additional information specific to the unlisted Plan species is also discussed under Alternative 2 (see Sections 4.2.2.1, Endangered Anadromous

Salmonid Species and 4.2.2.2, Other Anadromous Salmonid Species).

Wells Dam

The protection measures for unlisted Plan species under Alternative 3 would be the same as those discussed previously for the endangered species (see Section 4.2.3.1, Endangered Anadromous Salmonid Species). Based on fish passage efficiency information, the survival rates of the unlisted Plan species are expected to be comparable to those for spring-run chinook salmon and steelhead (see Table 4-1). As a result, substantial modifications to the juvenile bypass system are not expected to occur under Alternative 3. However, research and monitoring would be required for each Plan species to determine if the HCP survival standards are being met. Failure to meet these performance standards would require the use of interim tools and then additional tools or the implementation of the dispute resolution process. It is likely that increased spill would be implemented to improve survival rates, if necessary. Detailed discussions of the potential long-term implications of implementing the provisions of the HCP are provided previously in Section 4.2.3.1 under Juvenile Migration/Survival.

Project survival estimates from yearling summerrun chinook salmon and fish passage efficiency estimates for spring-migrating sockeye and summer-migrating subyearling chinook salmon indicate that the survival through the Wells Project for unlisted Plan species is sufficiently high that few, if any, modifications in existing project operations would likely be required to meet the Phase III goals of the HCP.

Rocky Reach Dam

Although project operations under Alternative 3 might be similar to those for Alternative 2, the effectiveness of these operations would be evaluated and modified, with the goal of achieving no net impact by no later than 2013.

Survival estimates are limited for the unlisted Plan species. The reservoir and dam passage survival studies conducted in 1998 and 1999 (Eppard et al. 1998; Bickford et al. 1999) estimated the total project passage survival for yearling fall-run chinook salmon at 85.9 percent (see Table 3-5). Although Bickford et al. (1999) also estimated chinook survival in 1998 at 93.9 percent, this was a single-release study that does not include all of the potential dam passage mortality (see Section 4.2.2.1, Endangered Anadromous Salmonid Species).

Additional survival estimates (based on the proportion of fish using each passage route and the assumed survival rate for each route) suggest that the survival is currently less than the 95 percent dam survival standards established for the HCPs (see Table 4-2, Alternative 1). Thus, additional protection measures are required to meet the HCP performance standards for all the Plan species. Chelan County PUD, with NMFS's approval, is currently constructing a juvenile bypass system in the cul-de-sac area of this project. This structure will be operational in 2003 and should improve survival of all Plan species. Chelan County PUD will conduct a fish passage efficiency study of the bypass system. This study is aimed at providing the necessary information to adjust spill levels in future years such that there is a high likelihood of achieving the survival standards for the unlisted Plan species. Phase I survival studies will be conducted in 2004, 2005, and 2006.

Protection measures planned to improve juvenile fish passage survival at the project are the same as those discussed previously for the Endangered Species Act-listed species (see Section 4.2.3.1, Endangered Anadromous Salmonid Species). However, the inclusion of these other Plan species under the no net impact provisions of the HCP might eliminate or limit the use of certain fish passage enhancement measures at the project. For example, sockeye salmon and early summer/fall-run chinook salmon migrants are believed to be more susceptible to injury and

descaling from turbine intake screens. This might prevent the use of additional intake screens to improve the surface collector bypass efficiency for spring-run chinook salmon or steelhead. Minimizing the use of intake screens might also benefit other fish species that are not specifically included as Plan species (e.g., Pacific lamprey).

As discussed, the inability to meet the specified survival performance standards for any of the Plan species by the end of Phase I (2006) would require additional protection measures for those species. The protection measures would be onsite structural or operational modifications. Failure to meet these performance standards would require the use of additional tools or the implementation of a dispute resolution process.

Rock Island Dam

The protection measures for unlisted Plan species under Alternative 3 would be the same as those discussed previously for the Endangered Species Act-listed species (see Section 4.2.3.1, Endangered Anadromous Salmonid Species). As previously discussed, the primary measures for maximizing juvenile fish passage survival at the Rock Island Dam are through spill and predator control programs.

Although survival measurements are limited for these Plan species, estimated reservoir and dam passage survival of PIT-tagged yearling chinook salmon ranged from 88.9 to 95.6 percent (see Table 3-5). Radio-telemetry evaluations estimated survival rates for hatchery and run-ofthe-river chinook salmon at 93.9 and 94.7 percent, respectively (Stevenson et al. 2000). However, the use of radio-telemetry to measure juvenile survival is a relatively new methodology, which has not been fully evaluated. As a result, PIT-tag studies are believed to provide more reliable estimates of survival. In addition, naturally produced fall-run chinook salmon outmigrate as subyearlings during the summer (as opposed to the hatchery-reared fall-run chinook salmon that outmigrate as yearlings during the spring). Thus, the application of these survival

estimates to summer/fall-run chinook salmon is only an approximation that would need to be verified under Alternative 3.

In addition, calculating individual survival rates for the various passage routes (using measured or assumed survival and passage rates for each passage route) suggest that the dam passage survival rate might be below the HCP performance standards (see Table 4-3). If this is verified through project-specific survival studies, additional measures might be needed to meet the survival standards for some or all of the unlisted Plan species.

These measures might include:

- improving additional spill gates,
- developing a powerhouse surface collector and bypass system,
- installing a forebay guidance curtain,
- installing turbine intake screens at Powerhouse 1, or
- modifying the turbines to increase turbine passage survival.

These plan protection measures, used individually or in combination, are expected to improve the survival of juvenile salmon and steelhead smolts passing the project to levels approaching the survival standards of the HCP. Failure to meet these performance standards would require the use of additional tools (see Figure 2-5) or the implementation of the dispute resolution process.

Adult Migration/Survival

The procedures and measures for improving adult migration and survival conditions for the unlisted Plan species would be the same as those discussed previously for listed species (see Section 4.2.3.1, Endangered Anadromous Salmonid Species). Although the protection

measures are expected to benefit all the Plan species, the extent of the benefit would vary by species.

Adult Reservoir Spawning

Under Alternative 3, changes in project operations would be primarily confined to structural changes at the projects and would be unlikely to substantially change river flow conditions. However, changes in spill patterns and volumes resulting from altered project operations to improve juvenile fish passage survival could alter downstream water quality conditions (see Section 3.3.2, Water Quality).

Potential effects on reservoir spawning of the Plan species under Alternative 3 are similar to those discussed previously for the Endangered Species Act-listed species (Section 4.2.3.1, Adult Reservoir Spawning). These effects include water level fluctuations, sedimentation or scouring of spawning habitat, and elevated total dissolved gas levels.

These factors could potentially affect summer/fall-run chinook salmon more than the other Plan species because summer/fall-run chinook salmon spawn primarily in mainstem areas where project effects would be greater. However, this species typically spawns in relatively deep water, and the resulting progeny migrate downstream soon after emergence. Therefore, project operations are unlikely to substantially affect the reproduction success. Any effects would be similar for all the EIS alternatives.

Hatchery Production

Potential changes in hatchery production levels and operational procedures affecting the Plan species are similar to those described for the endangered species in Section 4.2.3.1 under Hatchery Production. The initial hatchery production levels would remain unchanged until

at least 2013 under Alternative 3. Under Alternative 2, these production levels would not change. However, production levels could be reduced under Alternative 2 if NMFS determines that such levels would jeopardize the continued existence of the listed species, through direct or indirect interactions of hatchery fish with naturally produced fish (see Section 2.5.5, Artificial Fish Production).

Tributary Habitat Improvements

The procedures for making tributary habitat improvements would be the same as those discussed for the threatened and endangered species in Section 4.2.3.1, Tributary Habitat Improvements. PUD-funded habitat improvement measures are not included in either Alternative 1 or 2.

Monitoring and Evaluation

Monitoring programs under Alternative 3 would be similar to those discussed previously under Monitoring and Evaluation in Section 4.2.2.1, Endangered Anadromous Salmonid Species, although they would also include specific survival studies for all the Plan species to verify that the HCP performance standards are being met. These studies would make substantial contributions to:

- quantify the effects of project operations on all the Plan species,
- provide guidance to make appropriate structural and operational modifications at the projects to adequately protect these species, and
- assess the adequacy of the hatchery compensation levels at maintaining no net impact on the Plan species.

This information would be used in an adaptive management approach, which would assess the benefits or results of the protection plans to conserve and/or recover each Plan species. This adaptive management approach is an essential part of the HCPs because the protection measures rely on survival results rather than strictly dam operation procedures (e.g., fish passage efficiency).

4.2.3.3 Resident Fish Species

Project Areas

There are no intended changes to project operations specifically aimed at resident fish species under any of the alternatives. Therefore, the effects of project operations on resident fish in the project areas are not expected to differ substantially from either Alternative 2 or existing conditions (Alternative 1). Under all three alternatives, the appropriate agencies or coordinating committees would consider the potential effects that activities aimed at protecting the Plan species would have on resident fish. Salmonid species (particularly smolting fish) are generally more sensitive to environmental changes and more prone to physical injury (related to project passage) compared to most resident fish that occur in the project area. Therefore, bypass facilities designed to achieve a high level of salmonid passage survival would be unlikely to substantially affect resident species that pass the projects. An exception would be the possible use of turbine intake screens at Rock Island Dam. Intake screens are known to impinge juvenile lamprey.

Associated Tributaries

Resident trout spawn and rear in tributary streams throughout the Mid-Columbia River region. The spawning and rearing habitat requirements for these fish are similar to those used by anadromous salmonids. Therefore, potential habitat improvements resulting from projects funded by the Plan Species Account are expected to also benefit resident trout species. Descriptions

of the types of projects expected to be funded by 2.3.4.8, HCP Conservation Plan and Compensation Measures, under Tributary Conservation Plan.

Any reduction in hatchery anadromous fish production that might occur under the action alternatives would also reduce the potential effects of competition for food and space, disease transmission, or direct predation by hatchery fish on resident trout.

Pacific lamprey spawn in low-gradient stream segments of smaller tributaries, including streams feeding the mainstem reservoirs. The low-gradient segments of many of the Mid-Columbia River tributaries tend to occur in the lower watershed. These areas are also most likely to be affected by land-use practices (primarily farms and orchards). Thus, tributary improvement

The HCPs provide a funding source for improving tributary habitat that might be beneficial to non-Plan species, such as bull trout and Pacific lamprey. Although there are no plans or provisions to evaluate whether the habitat

the Plan Species Account are provided in Section projects (such as improving access, increasing stream flows, increasing instream habitat, and water quality improvements) in these areas are

water quality improvements) in these areas are expected to benefit lamprey spawning and rearing.

None of the EIS alternatives provide funds or specific provisions to address potential project effects to bull trout, which are currently listed as threatened under the Endangered Species Act. Bull trout are known to occur in the project area, and have been observed passing the projects through the adult and juvenile fish passage facilities. The potential take of this species would require a separate consultation under Section 7 of the Endangered Species Act between FERC and USFWS. Any future listings of non-Plan species would also require separate action under either Alternative 2 or 3.

improvements benefit or adversely affect non-Plan species, it is assumed that the tributary committees would consider effects to non-Plan species in the determination of which habitat improvement projects to implement.

4.3 WATER RESOURCES (QUANTITY AND QUALITY)

4.3.1 WATER QUANTITY

4.3.1.1 Alternative 1 (No-Action)

Project Area

Over the next 50 years, the mainstem Mid-Columbia River dams would continue to be operated by the PUDs with the primary objective of power production. These dam and reservoir operations are generally based on instantaneous power demands, as described in Section 2.2.2, Dam and Reservoir Operations. The number of turbines in operation and the resulting water discharge from each facility would continue to vary frequently, with typical daytime peak flows being about 135 percent of nighttime low flows.

Flow releases from the Chief Joseph Dam upstream are timed to increase power generation at downstream dams throughout the day. Hourly coordination among dam operators would continue to maximize power generation efficiency by minimizing reservoir drawdown and maintaining optimal water levels for the turbines.

To maximize power production, Mid-Columbia River dam operators would continue to minimize the amount of water that is discharged over spillways. Forced spill would occur whenever the reservoir is at its normal maximum operating level and reservoir inflows exceed the hydraulic capacity of those turbines being used to meet the instantaneous power demand. When forced spill does occur, it would typically be at night when energy demand is lowest.

Associated Tributaries

Water quantities in the Mid-Columbia River tributaries and other reaches of the Columbia River may change due to climatic factors, modified water withdrawals, or changes in the operations of upstream storage reservoirs and tributary dams. Wet and dry climatic cycles are difficult to predict, as are the potential effects of global warming. These factors influence the amounts of precipitation and the rate of snowmelt, and ultimately the river flows. There are currently no plans to change the operations of those projects upstream of the Wells Dam. Some future changes in tributary stream flows are likely to occur under Alternative 1 as irrigation withdrawals or other water uses change due to Federal, State, and locally funded enhancement projects and regulations being implemented to protect threatened and endangered species in the tributary watersheds. However, such changes would be unrelated to PUD reservoir management. Average discharge from each of the Mid-Columbia River tributaries ranges from less than 1 to about 6 percent of the average Columbia River flows during high-flow months (spring), and typically less than 1 percent during low-flow months (fall) (see Section 3.3.1, Water Quantity).

4.3.1.2 Alternative 2

Project Area

Monthly average flows and peak flows in the Mid-Columbia River and its tributaries are not expected to change under Alternative 2, beyond the possible changes discussed under Alternative 1. The frequency and quantity of forced spills are also not expected to change from existing conditions.

To provide additional protection for listed species, measures to increase downstream passage survival of juvenile salmonids would be instituted under Alternative 2. These measures

would include increased spill during specific migration time periods for the listed species. Although voluntary spill is limited by the requirement not to exceed the water quality standards for total dissolved gas, it is estimated that spill could increase to encompass 40 percent of the total river flow.

Because of the limited storage capabilities of the reservoirs, these potential changes in dam operations would have only a minor and short-term effect on river flows. During spill events, a portion of the river flow is directed over the spillway rather than through turbines; however, the total quantity of water released from the dam is generally not affected.

Reservoir drawdown, a measure to increase water velocities and decrease outmigration periods for juvenile salmon and steelhead, is a remote possibility for the next 50 years. If FERC licenses are amended to allow for drawdown, reservoirs could be drawn down by as much as 30 to 50 feet, and water particle travel times (the average time it would take for water molecules to travel through the reach in question) would substantially increase.

Associated Tributaries

Similar to Alternative 1, changes in water quantities in the associated tributaries would be attributed to independent actions and not related to Alternative 2 actions.

4.3.1.3 Alternative 3

Project Area

Water quantity in the project area under Alternative 3 would not be substantially different from Alternative 2. There are no proposed changes to operations at the three dams that would affect water quantity, and the development of juvenile fish bypass systems at Rocky Reach and Rock Island dams would likely be similar under both alternatives.

Improvements to the juvenile dam passage system could result in a reduction in the amount of spill at the projects, thereby reducing total dissolved gas levels, but would not affect the total river flow. As run-of-the-river facilities, the Mid-Columbia River projects have little influence over total river flows. Although the bypass system at Rock Island Dam is based primarily on spillway passage, the focus is to increase the efficiency of spill (e.g., passing more fish with less water). At Rocky Reach Dam, improvements to the surface bypass system could decrease the use of spill. However, spill could also increase due to the need to meet the HCP survival standards, if the standards cannot be achieved with existing spill levels and the juvenile fish bypass system.

Despite the potential changes in spill, these measures would not substantially alter water quantities (e.g., dam discharge rates, monthly flows, or peak flows) in the river. Modifications to the spill program or turbine systems would affect how the water passes a dam, but would not change river flows. Because of the very limited capability to store water in these run-of-the-river reservoirs, actions to avoid or minimize reservoir level fluctuations would have a limited influence on river flows.

Associated Tributaries

The water quantity in some Mid-Columbia River tributaries (i.e., the Wenatchee, Entiat, Methow, and Okanogan Rivers) could be improved under Alternative 3 compared to Alternatives 1 and 2 through tributary habitat improvements, funded as part of the HCPs. In the selection of habitat improvement projects for funding, high priority would be given to the acquisition of land or interests in land, such as conservation easements or water rights. These conservation measures would likely provide some improvements in tributary instream flow conditions, such as higher summer stream flows.

Most of the HCP habitat restoration strategies recommended for the Wenatchee River watershed center on efforts to maintain or increase the complexity of stream channels and floodplains (NMFS et al. 1998b). Benefits from several tributary riparian restoration projects include increasing late-summer instream flows and desynchronizing flood events.

Instream flow has been identified as a limiting factor in the Methow River (Washington State Conservation Commission 2000). Low-flow conditions are caused in part by irrigation diversions, and the effects are exacerbated by cold weather (which further reduces the available instream habitat). Efforts are underway to address this problem.

Water quantities in other tributaries of the Mid-Columbia River would not change under HCP habitat improvement strategies. Efforts to improve salmonid production in the Okanogan River drainage through facilitation and funding of improved agricultural practices would have little effect on flow and temperatures. However, implementation of the Okanogan Flow Management Program to mitigate for impacts to sockeye salmon from the Wells Project would affect flows in the Okanogan River. These flow manipulations would be developed to improve spawning and incubation conditions in the river that would benefit sockeye salmon and kokanee production. Implementation of this flow management program is expected to occur under all the alternatives.

Recommended strategies for Entiat River habitat enhancements focus on improving structural complexity of the stream channel and improving woody debris recruitment. These HCP recommendations for the Entiat River watershed do not target instream flows, and no changes in water quantity are expected to result from their implementation. Although some instream flow improvements might be expected over the 50-year term of the HCPs, these projects are not considered a priority in this basin.

4.3.2 WATER QUALITY

4.3.2.1 Alternative 1 (No-Action)

Project Area

Mid-Columbia River water quality may improve over time as Ecology continues to work toward compliance with the Clean Water Act. For all Washington streams that are listed as having impaired water quality under Section 303(d) of the Clean Water Act, including the Mid-Columbia River and its tributaries, Ecology is required to develop and implement total maximum daily load (TMDL) limits to restore water quality for beneficial uses. The Mid-Columbia River in the project area is currently on the 303(d) list for total dissolved gas, water temperature, pH, and a water column bioassay. Although draft TMDLs have been developed for the Mid-Columbia River, these standards are likely to change. As a result, they are not specifically addressed in the comparison of the alternatives. The PUDs are working directly with the USEPA on the draft TMDLs, and compliance with the final TMDLs would occur regardless of the alternative selected for this project.

Associated Tributaries

Water quality in the Mid-Columbia River tributaries is generally good, although they are or have been listed on the Ecology 303(d) list for several constituents (see Section 3.3.2.2, Associated Tributaries). The Wenatchee River is listed for exceeding the water quality standards for temperature, pH, and dissolved oxygen; the Methow River for temperature; and the Okanogan River for temperature, dissolved oxygen, fecal coliform, and various pesticides. Although the Entiat River has no current listings, it has been listed in the past for temperature and pH.

Water quality in the tributary rivers is also generally expected to improve over the next 50 years. In addition to Ecology efforts to develop

and implement TMDLs for compliance with the Clean Water Act, other agencies have undertaken watershed planning. These programs are critical to reverse the trend of water quality degradation. However, water quality is generally very good in the Mid-Columbia River tributaries, so progress would be slow to result in measurable improvements. Because these tributaries produce only a small portion of the total Mid-Columbia River flows, improvements in water quality may not be noticeable in the Columbia River mainstem. Water quality is generally not considered the limiting factor in Mid-Columbia River tributary salmonid productivity, so water quality improvements would have a limited ability to help fish without other habitat improvements (e.g., increased summer low flows and channel structure improvements).

A watershed action plan and implementation schedule have been developed to promote water quality improvements throughout the Wenatchee River watershed from pollutant sources such as on-site sewage systems, agriculture, forestry, and stormwater (Wenatchee River Watershed Steering Committee 1998). The Chelan County Conservation District has initiated a watershed planning process for the Entiat River that includes water quality evaluations (Jones 1999). Alternatives to enhance fish habitat by restoring riparian vegetation, if implemented, would provide increased shade and may reduce summer water temperatures. Efforts to improve instream flows through improved conservation practices in the Methow River watershed (Methow Valley Water Pilot Planning Project Committee 1994) may also improve water temperatures and other water quality constituents.

In the Okanogan River watershed, the Okanogan Conservation District and Okanogan County have joined with other agencies and interested parties to draft a plan that addresses non-point and point source pollution and identifies implementation strategies (Okanogan Watershed Stakeholder's Advisory Committee and Technical Advisory Committee 1999). Actions identified in this plan

directly address water quality improvements for constituents identified on the 303(d) list: water temperature, dissolved oxygen, fecal coliform bacteria, pH, dicholoro-diphenyl-tricholoroethane (DDT), poly-chlorinated biphenyls (PCBs), arsenic, instream flows, and turbidity and sediment.

Riparian reserve protection and other land management improvements on USFS lands may further improve water temperatures, dissolved oxygen concentrations, sedimentation, and other water quality variables in Mid-Columbia River tributaries. These efforts to improve water quality are expected to continue and result in incremental water quality improvements over time.

4.3.2.2 Alternative 2

Project Area

Of the Mid-Columbia River water quality constituents on the 303(d) list, total dissolved gas is directly affected by project area dam operations. Increased spills to facilitate juvenile salmonid migrations have the potential to increase total dissolved gas concentrations under Alternative 2. For example, if 93 percent juvenile project passage survival is required for protecting threatened and endangered salmonid species passing the Rocky Reach Project, then it may become necessary to divert more water to the spillway to increase survival. Conversely, actions responding to Ecology requirements and voluntary mitigation efforts by the PUDs (e.g., spill deflectors) are likely to reduce total dissolved gas downstream from the dams.

To comply with the Clean Water Act, the spillways would be modified to reduce total dissolved gas levels to no more than 110 percent saturation, or Ecology would grant waivers of the 110 percent total dissolved gas saturation standard to allow 115 percent saturation in project forebays and 120 percent saturation in tailraces to

improve fish passage over the spillway. Preliminary assessments suggest that, with revised standards or temporary waivers, it might be possible to spill up to 40 percent of the total river flow (if necessary to meet fish survival criteria) and still comply with the water quality standards for total dissolved gas. However, total dissolved gas abatement measures would be required at some locations, such as Rock Island Dam, to allow this level of spill. The ability to control total dissolved gas is likely to be a limiting factor in using spill to achieve the necessary fish survival rates under Alternative 2. Similar total dissolved gas abatement measures are expected to occur under Alternative 1.

Other water quality constituents on the 303(d) list for the Mid-Columbia River project area are generally not expected to change under Alternative 2. Because high dams upstream (e.g., Grand Coulee Dam) are not equipped to release cooler water from deep in the reservoirs, and because the project area reservoirs are run-of-theriver projects that warm up and cool off quickly with ambient temperature changes, little can be done to improve high summer water temperatures. The 303(d) decision matrix indicates that the pH listing was based on two excursions beyond the criterion in 1991, and remedies to the problem may not be available (Washington State Department of Ecology 1996).

If reservoir drawdown is implemented to improve juvenile salmon and steelhead outmigration survival in the spring, some marginal changes in water quality could occur. Measurable changes in water temperature are not expected to occur under the drawdown scenario. Some localized short-term increases in turbidity and suspended solids, resuspension of pollutants, increased nutrients, and possible downstream reductions in dissolved oxygen could occur, depending on the extent of drawdown. These effects would dissipate over time, and water quality would return to predrawdown conditions. Drawdown in not included as an option under Alternative 1.

Associated Tributaries

Similar to Alternative 1, Alternative 2 would have no effect on water quality in the Mid-Columbia tributaries, as no off-site measures would be implemented to avoid jeopardizing the continued existence of the listed species. Habitat restoration activities under Alternative 2 are expected to occur through funding sources other than the PUDs, and would be similar to those already planned in the region and discussed above for Alternative 1.

4.3.2.3 Alternative 3

Project Area

Similar to Alternative 2, water quality in the Mid-Columbia River may improve over time under Alternative 3 as Ecology implements TMDL limits for parameters that do not meet water quality standards. Efforts to meet 93 percent juvenile project passage or 95 percent juvenile dam passage survival for all Plan species may include diverting more river flow to spillways where fish survival is generally higher than other passage routes (particularly the turbine passage route). Increasing spill levels to improve survival rates is more likely at Rocky Reach and Rock Island dams than at Wells Dam because of the efficiency of the Wells Dam surface bypass system. Reduced spill levels are expected to occur under Alternative 3 at Rocky Reach Dam, compared to Alternatives 1 and 2, because of the expected reliance on the juvenile bypass system

to increase juvenile survival at the projects. Spill is the primary method to improve juvenile passage survival at Rock Island Dam for all the alternatives, although spill levels are expected to be greatest under Alternative 2 and the lowest under Alternative 1.

Increased spill to improve fish survival could result in higher total dissolved gas supersaturation, thereby conflicting with efforts to meet the water quality standards for total dissolved gas. The HCPs commit the PUDs to work cooperatively with Ecology to meet water quality standards. Some combination of mitigation to reduce gas entrainment at spillways (e.g., spill deflectors) and changes or waivers for the 110 percent saturation limit would likely be necessary to meet HCP commitments to both the fish survival and water quality standards. The signatory parties to the HCP have committed to work together to address water quality issues (see Section 6, Reservoir Habitat and Water Quality of the Wells, Rocky Reach, and Rock Island HCPs).

Associated Tributaries

The tributary habitat improvement projects funded by the HCPs are expected to benefit water quality. For example, water conservation measures that increase summer low flows would also lower water temperatures and improve dissolved oxygen conditions during this critical time of the year. No PUD-funded tributary improvement projects are included under Alternatives 1 and 2. As a result, no changes in tributary water quality are expected.

4.4 VEGETATION

4.4.1 **ALTERNATIVE 1 (NO-ACTION)**

4.4.1.1 Project Area

Ongoing operations at the three dams would have no effect on vegetation (including wetlands) within the project area. There are no plans to change water levels beyond existing conditions under any of the FERC licenses.

4.4.1.2 Associated Tributaries

Planned projects that are outside of the jurisdiction of the PUDs would affect riparian

vegetation located in the watersheds of the four tributaries. As part of the Federal- and Statemandated WRIA and USFS habitat improvements, riparian habitat along the associated tributaries would be acquired for preservation, enhancement, and restoration. Larger buffer areas along the stream corridors would be set aside and converted from existing land uses (largely agricultural) to riparian habitat.

Habitat improvements by sources other than the PUDs may involve the removal of non-native or agricultural plant species; adding or enhancing soils; and planting native riparian, wetland, or upland overstory vegetation. Habitat conservation areas may also be protected from human intrusion. These actions would have a beneficial effect on vegetation by removing nonnative species, converting disturbed areas back to a more natural state, and increasing plant survival rates. These projects are independent of the three dams, and would occur regardless of the action alternative selected. Ongoing hydroelectric project operations would have no effect on vegetation in the project area, including the four tributaries. Habitat restoration projects are independent and would not affect any restoration efforts conducted through the WRIA initiatives or other Federal, State, local, or voluntary restoration projects.

4.4.2 ALTERNATIVE 2

4.4.2.1 Project Area

Under Alternative 2, the three projects would implement measures to improve adult and juvenile fish passage past the dams, continue the funding of the hatchery programs, monitor and evaluate the success of fish passage measures, and analyze the potential for fish survival and recovery with the proposed measures. Some of the actions that would be implemented at the dam sites include modifying ladder operations, in particular improving the entrances to the ladders;

operating the surface bypass system continuously during migratory periods; operating turbines at peak efficiencies; increasing amount and extent of spill; and implementing a predator removal program and a gas abatement program. Similar to Alternative 1, the actions associated with dam facility improvements are in-water improvements and would have no adverse effect on shoreline vegetation.

The increased program of spills at the dams during fish migratory periods would also have no adverse effect on shoreline vegetation. This is because there would be no change to the existing water level fluctuations downstream of the three dam sites.

Unlike conditions under Alternative 1, another potential (but remote) operational change that could occur over the next 50 years under Alternative 2 may be to drawdown reservoirs as part of NMFS's regulatory authority to ensure salmon and steelhead survival. Drawdown would affect riparian zone vegetation and wetlands located near the reservoirs, as well as aquatic bed vegetation. The relatively static nature of the water levels in the reservoirs has resulted in the formation of wetlands and mature riparian vegetation in those areas that are not developed for orchards, other agriculture, or development, or rip-rapped to prevent erosion. Drawdown would result in loss of riparian, aquatic, and wetland vegetation because these vegetative types are dependent on being saturated or located near a constant water supply.

One rare plant species could also be affected by the potential drawdown of the reservoir pools under Alternative 2. The giant helleborine is known to occur on or near the three reservoir shorelines. Drawdown could also increase the potential spreading of noxious weeds into currently wetted areas that would be exposed during drawdown conditions. This effect would not occur under Alternative 1.

4.4.2.2 Associated Tributaries

Similar to conditions under Alternative 1, implementation of Alternative 2 would have no effect on vegetation in the tributaries. Independent habitat restoration conducted by other agencies or voluntary organizations and individuals would also occur and likely result in improvements in native vegetation habitats.

4.4.3 ALTERNATIVE 3

4.4.3.1 Project Area

Similar to Alternatives 1 and 2, there would be no effects to vegetation within the project area from any construction and operation improvements that may occur from implementation of this alternative. The only exception would be vegetation effects from drawdown, which have the potential of occurring under either Alternative 2 or 3. Drawdown effects from implementation of Alternative 3 would be the same as described under Alternative 2. These effects include loss of riparian, wetland, and aquatic vegetation. Over time, new riparian, wetland, and aquatic vegetated areas would be created at the lower elevation shoreline.

4.4.3.2 Associated Tributaries

Tributary improvements planned, designed, and implemented independent of the action alternatives would likely include land acquisition and habitat improvement of shoreline areas along the four tributaries. Additional funding would be available under the HCPs, and thus a greater level of habitat restoration would be possible. HCP actions that occur at the project areas would not affect vegetation in the tributaries. Some of the main areas where tributary riparian vegetation has been recommended for protection and restoration using HCP funding include the following:

Wenatchee watershed

Lower White River

Lower Wenatchee River

Lower Peshastin Creek

Lower Nason Creek

Lower and Upper Icicle Creek

Chumstick Creek

Ingalls Creek

Negro Creek

Camas Creek

Mission Creek

Brender Creek

• Entiat watershed

Lower Entiat River

Mud Creek

Mad River

Preston Creek

Fox Creek

Stormy Creek

Roaring Creek

Methow watershed

Lower Gold Creek

Lower Twisp River

Lower Chewuch River

Lower Benson Creek

Lower Lost River

Upper and Lower Methow River

Beaver Creek

Hancock Creek

Wolf Creek

Okanogan watershed

Upper mainstem Okanogan River Lower Similkameen River

4.5 WILDLIFE

4.5.1 ALTERNATIVE 1 (No-ACTION)

4.5.1.1 Project Area

Wildlife habitat enhancement and monitoring (e.g., installation and monitoring of Canada geese nesting structures and wood duck nest boxes) at the project locations are currently conducted according to FERC licensing agreements, as well as on a voluntary basis. These activities would continue under Alternative 1. The PUDs would also continue to fund avian predator control programs to reduce the level of gull, cormorant, and other piscivorous bird predation on juvenile salmon at the dams and the PUDs' hatcheries. There are no threatened and endangered species affected by current licenses.

4.5.1.2 Associated Tributaries

Due to the presence of threatened and endangered fish species in the associated tributaries, a variety of habitat improvements are likely to take place through independent agency actions in the associated tributaries. Watershed action plans are currently underway in the four tributaries, and include habitat protection, preservation, and improvement projects. These activities (funded by Federal, State, and local entities) include both instream enhancement and riparian habitat and floodplain restoration and enhancement.

4.5.2 ALTERNATIVE 2

4.5.2.1 Project Area

Similar to Alternative 1, the Alternative 2 fish protection and enhancement actions that would occur at the dams would have a negligible effect on most wildlife, including Federally proposed species, species of concern, State-listed species, State candidate species, or State monitor species. Because wildlife species do not pass through the

dams, improvements to adult fish passage (e.g., hydraulic and structural fishway modifications, improvements to juvenile passage from changes to spill programs and installation [Rocky Reach and Rock Island Dams], and modification [Wells Dam] of permanent juvenile bypass facilities) would have no direct effect on wildlife.

Fish passage improvements at the dams could indirectly affect piscivorous birds. Disoriented juvenile salmonids are a substantial source of prey for piscivorous birds, which concentrate around the dams during juvenile salmonid migration. If improvements to juvenile bypass systems cause less disorientation to juvenile fish, piscivorous bird prey availability in the tailrace would be reduced. This reduction in prey availability, combined with the intensification of avian predator control measures (such as installing more avian overhead exclusion wires and increasing hazing activities) may result in a decline in piscivorous birds in the vicinity of the dams. Similarly, if avian predator control activities are intensified at the hatcheries. piscivorous bird abundance would likely decline at these locations. Consequently, there is likely to be a lower abundance of piscivorous birds compared to Alternative 1.

Other wildlife species that occur in the project area do not depend on juvenile or adult salmon and steelhead as prey, and thus would not be indirectly affected by improved fish passage at the dams. Mink do prey on salmonids, but other prey (other fish, birds, and mammals) constitute the majority of their diet. Therefore, changes in salmonid abundance or passage rates at the dams would not affect mink populations in the area (Verts and Carraway 1998). River otters prey on fish to a greater extent than mink, but for otters in the vicinity of the dams and reservoirs, slow-moving resident fish (such as northern pikeminnows and suckers) likely comprise the majority of their fish prey (Toweill and Tabor

1982). Consequently, changes in resident fish abundance resulting from the pikeminnow removal programs may negatively affect the populations of river otters in the vicinity of the dams (Verts and Carraway 1998). In comparison to Alternative 1, there would likely be no changes in other wildlife species, excepting river otters, which could have a reduction in their preferred prey species under Alternative 2 but are not expected to be affected under Alternative 1.

In the unlikely event of drawdown, effects would depend on the timing, extent, and duration of drawdown. Waterfowl would be affected through reductions in plant forage, invertebrate prey, and nesting/brood-rearing backwater areas, and an increase in predator access to nest sites. Effects of drawdown to amphibians would include stranding of egg masses and loss of breeding and foraging habitat. Den sites of aquatic furbearers would be lost through lowering of the river water level, and these species could also be affected by reductions in food availability (i.e., riparian and aquatic vegetation and resident fish species). These effects would not occur for Alternative 1 because drawdown is not planned under existing conditions.

4.5.2.2 Associated Tributaries

As with Alternative 1, no PUD-funded habitat improvement projects would be conducted during the 50-year term of Alternative 2. However, similar to Alternative 1, a variety of independently funded habitat improvement projects are likely to occur that could improve wildlife habitat over time, such as an increase in riparian habitat, restoration, and instream habitat enhancement.

4.5.3 ALTERNATIVE 3

4.5.3.1 Project Area

As with Alternatives 1 and 2, likely fish protection and enhancement actions that would

take place at the dams under Alternative 3 would have a negligible effect on most wildlife. Potential effects to piscivorous birds could occur as under Alternative 2, if juvenile salmonid passage improves and avian predator control activities are intensified.

4.5.3.2 Associated Tributaries

Habitat improvements under Alternative 3 would include the PUDs funding projects to improve the productive capacity of salmonid habitat present in associated tributary streams. These PUD-funded projects would be in addition to tributary habitat improvement projects independently funded by other resource agencies. Projects funded by the HCPs would include both habitat protection and habitat restoration. Habitat protection projects would focus on maintaining existing floodplain and riparian areas. Such actions would prevent these areas from being converted to residential and other developments. Consequently, although these types of projects would not represent an immediate benefit for wildlife, the projects would prevent riparian and floodplain habitat loss. As such, habitat protection projects associated with the HCPs would have long-term benefits for riparian- and aquatic-associated wildlife (including waterfowl, aquatic furbearers, riparianassociated songbirds, and other species such as deer and black bear that use riparian habitats intermittently). These additional wildlife benefits would not occur under either Alternatives 1 or 2.

During the season of construction, these activities would cause short-term noise and visual disturbance. Wildlife species would either be lost or displaced to other areas during the time of disturbance. However, most species would return to the area upon completion of the construction activities. Projects may also cause a short-term loss of habitat, as construction equipment and use may destroy existing vegetation. Cleared areas would likely be replanted with native vegetation that provides optimum conditions for large woody debris entry into adjacent streams. Short-

term disturbance could occur to bald eagles; however, over the long term, the habitat improvements would increase the number of bald eagle prey. Riparian habitat improvements are likely to increase waterfowl foraging and nesting habitat.

Apart from the short-term disturbance to wildlife, these tributary projects would improve conditions for wildlife, depending on the types of projects that occur. Plantings of riparian vegetation would provide increased nesting, foraging, and breeding habitat for riparian-associated birds, and forage and cover for beaver, as well as deer and other land mammals. Changes to stream hydrology that could occur with habitat improvement projects, such as creation of eddy and backwater areas, would improve foraging and breeding habitat for waterfowl and amphibians. Improvements in salmon and steelhead spawning habitat, and concomitant increases in spawning salmon, would represent an increase in prey availability for black bear, river otter, and turkey vultures and other carrion-eating birds.

Habitat protection projects that would have the most benefit to wildlife are projects in areas that currently contain good wildlife habitat (i.e., presence of riparian trees and shrubs and good aquatic habitat) but are threatened by development.

Habitat restoration projects would include enhancing riparian habitat, restoring floodplain function, and improving fish passage to wetlands. Riparian and aquatic habitat improvements would cause a short-term disturbance to wildlife in the vicinity, but would have long-term benefits to songbirds, raptors, waterfowl, aquatic furbearers, amphibians, and land mammals that occasionally use riparian habitats.

One possible exception to beneficial effects of habitat improvements is the effect of fish introductions on amphibians. If fish passage is improved such that anadromous and resident fish gain access to areas that are currently occupied by amphibians but devoid of fish, effects to amphibians could occur. Fish prey on amphibians and can cause local declines or extinction in amphibian populations (Blaustein and Wake 1990; Corn 1994). Habitat restoration projects that would have the most benefit to wildlife are those that involve restoring riparian vegetation and improving wetland and backwater habitats. These effects could occur under any alternative because independent and PUD-funded tributary enhancement projects could open up portions of streams to fish that may have been recently closed to fish passage due to habitat deterioration or other fish blockage conditions.

4.6 LAND OWNERSHIP AND USE

4.6.1 ALTERNATIVE 1 (No-ACTION)

4.6.1.1 Project Area

Existing FERC licenses for the three dams would not alter land uses or zoning in the vicinity of the project area.

4.6.1.2 Associated Tributaries

As part of the Federal, State, and local watershed improvements that have been identified to improve endangered fish habitat, land along the shorelines of the tributaries may be acquired for preservation and restoration. This would convert existing private land ownership to public land and change the main land use (agriculture) to natural habitat and conservation. There are several other land use implications of this change in ownership:

(1) there would be less access to the shoreline areas for recreation, (2) there would be no additional residential development along the shoreline, (3) no industrial uses would be allowed near the shoreline, and (4) some zoning may change based on whether public entities purchased private lands, or other voluntary land use restrictions were placed on private lands.

Historical floodplain areas could return to floodplain conditions to provide increased salmon habitat. There may be some areas where the rivers or streams would be allowed to flood naturally. Many of these areas that have been protected from flooding and land uses (such as homes or agriculture) occur in floodplains. As part of allowing flooding to occur, there may be areas where the existing land uses (such as residences) could be displaced, and these properties would be acquired. The potential for these activities to occur exists regardless of the alternative selected for the three hydroelectric projects. Operations under Alternative 1 would not affect these proposed land use changes.

4.6.2 ALTERNATIVE 2

4.6.2.1 Project Area

Protection measures for fish migrating past the dams would include hydraulic and structural fishway improvements to allow for increased upstream passage by adult fish, such as modifications to ladders and changes in water flow to attract fish. Measures would also be implemented to increase the downstream passage of juvenile salmonids (such as increased spill programs, improved fish bypass systems, expanded predator control devices, and improvements to reduce dissolved gas levels). The planned structural and facility improvements at the dam would not change predominant adjacent land uses or zoning: power production, fish survival and production, tourism, or zoning along the Columbia River. However, other potential dam operations (such as drawdowns)

would change agricultural land uses, particularly along the shorelines and on the river itself. Zoning may also change dependent on the altered land use. Alternative 2 is similar to Alternative 1, except under drawdown conditions, which would not occur under Alternative 1.

Drawing down the reservoirs would make it considerably more difficult to obtain irrigation water for agriculture. Inflow lines would be extended and larger pumps would be needed. This work would require a one-time capital cost, and would also increase yearly maintenance costs. These factors could result in loss of irrigated agricultural lands in the vicinity of all three dams, which may also affect zoning as agriculture is converted to commercial/industrial, residential, or other land uses. These effects would not occur under Alternative 1.

4.6.2.2 Associated Tributaries

Alternative 2 would not affect any land use along the associated tributaries, and the effects from independently funded watershed improvements as described under Alternative 1 would also be applicable under Alternative 2.

4.6.3 ALTERNATIVE 3

4.6.3.1 Project Area

Similar to Alternatives 1 and 2, land use and zoning at the three dams would not substantially change under Alternative 3 (excepting under drawdown conditions). While there would be modifications to structures and operation of the dams to improve fish passage and survival, the land use would remain oriented to power production, fish survival and production, and tourism. None of the on-site modifications would affect any off-site areas near the dams or reservoirs.

When making land use or related permit decisions on PUD-owned lands that affect reservoir habitat.

the PUDs would consider the cumulative effects that land use decisions may have on the PUDs' ability to meet the conservation objectives of the HCPs, their respective FERC license requirements, and other applicable laws and regulations. They would notify and consider comments from the HCP signatory parties regarding land use permit applications on PUD-owned lands. In addition, they would notify all applicants for permits to use or occupy project lands or water that such use may result in an incidental take of Endangered Species Act-listed species.

The drawdown effects to land uses and zoning described under Alternative 2 could also potentially occur under Alternative 3. These effects would not occur under Alternative 1. This would include loss of agricultural lands, and potential conversion to industrial/commercial, residential, or other land uses.

4.6.3.2 Associated Tributaries

The Plan Species Account could provide money to acquire easements or purchase property for habitat improvements along the four main project tributaries. This work would be in addition to the Federal, State, and local effort to preserve and enhance habitat that is common to all three alternatives. Habitat improvements would largely focus on the riparian areas that presently are used extensively for agriculture, but may also include some scattered residential and commercial land uses. Protecting these areas would require the acquisition of land along the shoreline and conversion from its present land use to an undisturbed shoreline buffer. This buffer area would likely be a formally designated land use type similar to a Native Growth Protection/ Conservation Easement. Certain types of activities, such as farming, would then be prohibited from occurring within the buffer area.

It is not possible to predict the extent of land acquisition and conversion to the shoreline buffer at this time, because off-site habitat compensation measures have not yet been fully evaluated, and land values for particular land acquisitions have not been determined. However, the three dams would make a yearly contribution to the Plan Species Account, and there would be an opportunity to provide meaningful off-site habitat improvements for fish through these land acquisitions. As a result of this funding, there would be some shoreline areas along the four tributaries acquired for this purpose. Agricultural areas are likely candidates for conversion to shoreline habitat, as well as floodplains (as discussed under Alternative 2).

The types of land ownership potentially affected by land acquisition include private ownership, particularly in the lower reaches of the Wenatchee, Entiat, and Methow Rivers and most of the Okanogan River, except for the Colville Indian reservation lands along the lower reaches of the Okanogan River. There are also some scattered public lands administered by the BLM and State-owned lands located along the Entiat, Methow, and Okanogan Rivers. National Forest lands occur along the riparian and shoreline areas of the upper reaches of the Wenatchee, Entiat, and Methow Rivers.

Acquisition of these lands and conversion from agricultural to conservation areas would likely affect zoning in the area. The additional zoning change from implementation of Alternative 3 would not occur under Alternatives 1 and 2.

4.7 SOCIOECONOMICS

4.7.1 ALTERNATIVE 1 (No-ACTION)

Socioeconomic effects can be either direct or indirect. Direct effects result when employment or expenditures in an industrial sector either increase or decrease (for example, when a new manufacturing plant moves into an area and hires new workers). Indirect economic effects result when one industry purchases goods and services from another. For example, when a manufacturing plant closes, income to restaurants may be affected because there are fewer workers eating meals out.

Employment and economic activity is supported by the three hydroelectric projects in several industrial sectors. Employees working at the dams and hatcheries are either government employees or contract personnel, and overall, are an important part of the local economies (see Table 3-15). Project area construction workers usually live in the general project area and indirectly support the local economy.

Scientific research and engineering studies for the projects are often conducted outside of the three counties by service-sector employees in the Puget Sound or Tri-Cities area. This employment sector is relatively larger statewide than in the project counties. This activity has relatively little affect on the local economy.

The hydroelectric projects also support agricultural employment by providing a source of affordable electricity and allowing access to stable river elevations that are conducive to the withdrawal of irrigation water for orchards and crops located near the reservoirs. Agricultural employment is a very important component of the local economy, in both direct and indirect employment. Although irrigation could occur without the hydroelectric projects, substantial modifications to the existing facilities would be required.

Tribal economies would be directly affected by continuing the current operations at the three dams. Results of the QAR suggest that continued operations would have a high potential to result in the likely extinction of Upper Columbia River spring-run chinook salmon and steelhead stocks in the next 100 years, if survival continues in the future as it did between 1980 and 1994 (this assumption is conservative). Tribes rely on the fish harvest for income, as well as subsistence. For example, these two fish species constituted approximately 47 percent of the subsistence fish harvest in 2000. Steelhead alone accounted for 20 percent of the commercial fish harvest in 2000. The decline in these two fish stocks would take place slowly over time, but this would require Tribal members engaged in fishing to find replacement for the loss of income and subsistence resources.

Independently funded tributary habitat enhancements, improvements in fish passage survival at Lower Columbia River dams, and modification of harvest regulations and hatchery practices are likely to benefit fish stocks (listed and unlisted species) and thus the segment of Tribal economies dependent on the fish harvest. These activities would occur under all three of the alternatives.

4.7.2 ALTERNATIVE 2

Most current activities at the three hydroelectric projects would continue under Alternative 2. There would be some change in the direct and indirect employment related to the projects. Hatcheries would continue operating at their current level. Continued operation and maintenance of the facilities and modifications to improve fish passage would provide some employment in the government and construction sectors. Ongoing studies and research would be required to evaluate and monitor how the projects affect spring-run chinook salmon and steelhead.

This work would be primarily performed by government and private scientists and construction employees residing in Chelan and Douglas counties, as well as scientists from throughout the region. However, no substantial changes in employment and economic activity are likely under Alternative 2 compared to Alternative 1.

The possibility of additional future protective measures over the next 50 years under Section 7 of the Endangered Species Act remains open. These measures could require structural and operational modifications to the projects that could affect recreational activities and regional employment. If the projects are required to operate at minimum pool levels to improve fish passage, recreational activities could be substantially reduced. This would have a substantial adverse effect on the local county economies. Structural modifications at the dams include the construction of fish bypass systems, nitrogen abatement structures, and potential modifications to fishladders that could provide short-term increases in construction employment. These employment increases could have shortterm benefits to the local and regional economies.

If drawdown occurs, reduced pool elevations would substantially impair the production of electricity and would have a resultant impact on local hydropower-related employment and construction. Drawdown would also affect irrigation for adjacent agricultural areas, primarily fruit orchards. Many water withdrawal systems would have to be modified to reach the lower water level, resulting in a one-time capital cost. Lower water levels would also require more energy to operate the pumps, increasing operating costs. Increased costs could cause some orchards to go out of business, which would affect Douglas and Okanogan counties more than Chelan County. Since agriculture is a primary industry for these areas, there would be a substantial effect on other businesses in the area. This effect would not occur under Alternative 1.

The economic effects of Alternative 2 could be severe if pool levels were substantially reduced, including the loss of hydropower-dependent jobs and increases in electricity prices for farmers and businesses in the local communities served by the PUD dams. However, the likelihood of implementing drawdown is low.

Future protective measures developed for listed fish species under Section 7 of the Endangered Species Act would modify existing FERC licenses, settlement agreements, and interim stipulations. However, at this time, it is unknown if FERC or the PUDs would support the proposed measures. Therefore, negotiations to resolve biological and technical issues may take some time, thus delaying assistance to listed species. This may contribute to further declines in the two listed fish species. As described under Alternative 1, declines in spring-run chinook salmon and steelhead would affect Tribal economies, as these two species constitute substantial components of the Tribal fish harvest.

The QAR indicates that listed species survival would increase once protective measures are in place, such as a 93 percent juvenile project passage survival rate. With this passage rate, listed species' juvenile survival rates are predicted to increase from 116 to 135 percent over current levels. Increases in spring-run chinook salmon and steelhead survival would benefit Tribal fishing economies, provided that similar survival rates occur at the four Federal dam projects on the Lower Columbia River. These benefits described would not occur under Alternative 1. However, Alternative 2 may not necessarily benefit fall chinook and sockeye salmon; therefore, harvest benefits may not occur.

Drawdown of the Wells reservoir would have a negative effect upon that portion of the Colville Tribal economy that is dependent upon water being withdrawn for orchard, cropland, and grazing pastures along the shorelines of Lake Pateros. It is not clear what effect a drawdown would have on fish survival. While natural river

drawdown would help to mimic natural river conditions prior to construction and operation of the three dams, minimum pool drawdown has not been shown to improve juvenile survival in the Mid-Columbia River. Therefore, it is not possible to predict the effect of a drawdown on the Tribal fishing economy.

Effects from independent tributary habitat enhancements would be the same as under Alternative 1.

4.7.3 ALTERNATIVE 3

Similar to Alternative 2, most current activities at the three hydroelectric projects would continue under Alternative 3. Operation and maintenance of the facilities and modifications to improve fish passage would be similar to current activities and would continue to provide employment in the government and construction sectors. The continued funding for hatchery operations would not have any economic effects because it would be a continuation of existing expenditures, and therefore would not create new jobs or have other economic effects. Extensive use of survival studies and research to monitor and evaluate the effects of the hydroelectric projects and hatcheries on survival and recovery of anadromous salmonid species would be required for the 50-year term of the HCPs. Chelan and Douglas County PUDs perform much of the monitoring and evaluation in-house. When consultants are used, they are regularly hired from the local or regional workforce. Some monitoring would also occur under Alternatives 1 and 2, and the extent of monitoring under Alternative 2 is not as well defined over the 50-year time period as under Alternative 3.

Alternative 3 includes new funding of off-site activities to increase salmonid productivity in areas other than the project reservoirs and facilities. A Plan Species Account would be established and supported with contributions from each of the PUDs. Money would be provided to acquire mitigation sites and to support operation

and maintenance of off-site mitigation measures. The habitat protection and restoration activities funded by the Plan Species Account would be carried out by local watershed and conservation groups, realtors and surveyors, land use consultants, and general contractors. Some of these actions would also occur independent of any alternative, but more activities would occur under Alternative 3.

The funding for off-site measures would bring new expenditures into the area, create new jobs, and provide new income. The expenditures would most likely be in the consulting and general construction industry in the three project counties (Chelan, Douglas, and Okanogan).

For the Wells Project, the Douglas County PUD would make an initial contribution to the fund of \$1,982,000 in 1998 dollars. The expenditure would generate an expected 8 jobs in the local construction industry and 21 total jobs in the region. After 5 years, the PUD would either make annual payments of \$176,178 (1998 dollars) through the term of the HCP or an upfront payment of \$1,761,780 (equivalent to 10 annual payments in 1998 dollars). If the 10-year up-front payment option were selected, the HCP parties would determine how the remaining annual payments would be made. This funding would generate one construction job and two total jobs in the region.

For the Rocky Reach Project, Chelan County PUD would fund the Plan Species Account at \$229,800 (1998 dollars) annually. This funding would generate two construction jobs and five total jobs in the region.

For the Rock Island Project, the Chelan County PUD would fund the Plan Species Account at \$485,200 (1998 dollars) annually. This funding would generate 4 construction jobs and 10 total jobs in the region.

The new expenditures for off-site habitat improvements would have a very small positive

effect on the local economies. Since the combined labor force for the three counties was 63,679 in 1998, even a maximum increase of 38 jobs would not be substantial, but would be greater than under either Alternative 1 or 2.

Alternative 3 would also provide economic benefits by ensuring that the projects could continue to operate in a manner that supports agricultural and recreational activities. This is not as likely under either Alternatives 1 or 2.

Long-term protection and recovery plans for all Plan species, as well as Endangered Species Actlisted species, would be developed under this alternative. This would not occur under either Alternatives 1 or 2. The QAR indicated that juvenile survival rates for listed species would increase from 123 to 149 percent over current levels. Increases in spring-run chinook salmon and steelhead survival would benefit Tribal and local fishing economies. Further increases in fishing and fish returns would be provided should further survival improvements be implemented at the four Federal dam projects on the Lower Columbia River.

In addition to listed species, other Plan species' survival would be improved. This would result in healthier stocks of other fish species that compose

the Tribal fishery, such as fall chinook, coho, and sockeye salmon. This would have a beneficial effect on Tribal economies in terms of maintaining the existing levels of fish take for income or subsistence purposes. If fish stocks continue to improve, this alternative could result in additional jobs and income for the Tribes. This benefit would not occur under Alternative 1 and has the potential to occur under Alternative 2, although primarily for listed species.

Effects from independently funded tributary habitat enhancements, improvements in fish passage survival at Lower Columbia River dams, and modification of harvest regulations and lower river hatchery practices would be similar to those proposed under Alternatives 1 and 2. Effects from drawdown of the reservoirs behind the three dams would be similar to those described for Alternative 2.

In summary, Alternative 3 would result in socioeconomic benefits by creating additional jobs and providing new income and expenditures in the local economies through the funding of offsite activities to increase salmonid productivity. This effect would be in addition to those independent WRIA-funded activities that would occur under any of the alternatives.

4.8 ECONOMICS

This section describes the costs of the three alternatives over the next 50 years (see also Section 3.8, Economics, for additional information and definition of key terms). Alternative 1 represents the no-action alternative, or implementation of existing conditions with no changes over the next 50 years. Alternatives 2 and 3 include the costs of implementing the mitigation measures associated with each of these action alternatives. Subtracting costs and foregone power revenues of Alternatives 2 and 3 from Alternative 1 provides the increased cost of implementing the additional fish conservation measures associated with Alternatives 2 and 3.

Each of the alternatives would reduce the amount of available capacity and energy that can be generated at the Wells, Rocky Reach, and Rock Island hydroelectric projects. This is primarily a result of spill. The lost capacity and energy of the three hydroelectric projects (combined) during the months of March through September are as follows:

- Alternative 1: 87 average megawatts of energy and 316 megawatts of capacity per month,
- Alternative 2: 628 average megawatts of energy and 1,064 megawatts of capacity, per month, and

 Alternative 3: 168 average megawatts of energy and 439 megawatts of capacity per month.

This information is illustrated in Figures F-7 through F-15 (Appendix F).

4.8.1 EVALUATION METHODOLOGY

The economic evaluation of each alternative is based on an incremental approach, which means that the economic cost of each alternative was determined by estimating the life cycle costs and the forecasted foregone power revenues (based on replacement cost in the wholesale power market) for each of the alternatives. Costs and benefits for this analysis are based on the costs and benefits associated with fish conservation measures. The analysis does not include or quantify hydroelectric costs or benefits not related to project alternatives.

The evaluation was conducted over the projected 50-year life of the alternatives. It accounts for future projected inflation, real cost (not including inflation), power price, and the time value of money. Three generally accepted approaches for presenting the results are as follows:

- net present value,
- levelized value, and
- first year value.

Refer to Section 3.8, Economics or the Glossary for a definition of these values. To provide a thorough evaluation, all three approaches were used in this economic analysis.

The key economic parameters used for this analysis are summarized below:

discount/interest rate: 7 percent,

date of initiation: 2002,

• period of analysis: 50 years,

• general inflation rate: 2.5 percent, and

• real growth rate: 1.0 percent.

Table 4-5 summarizes the key power pricing parameters used in this analysis to develop the replacement costs of lost power from spill.

The electricity price forecast used in the analysis is based on costs of owning and operating natural gas-fired combined-cycle and single-cycle combustion turbines. The power value for the light-load hours (10 p.m. to 6 a.m. Monday through Saturday and all day Sunday) is based on the variable cost of operating a combined-cycle combustion turbine. The peak heavy-load hour power values are based on the full costs (fixed and variable) of a gas-fired combined-cycle turbine. The power value of the super-peak heavy-load hour is based on building and operating a single-cycle combustion turbine. The power pricing parameters that were used to calculate energy replacement costs are provided in Table 4-5.

Figure 4-1 illustrates the electricity price forecast in nominal and real terms over the 50-year life of the alternatives. The future real amounts do not include inflation, whereas the future nominal amounts include the effects of inflation.

4.8.2 ALTERNATIVE 1 (No-ACTION)

Alternative 1 capital costs vary by project (Figures F-1 to F-3 [Appendix F]). Capital costs for the Wells Project include large nonrepetitive costs associated with some of the more expensive fish studies. For the Rocky Reach Project, Alternative 1 costs are associated with the bypass construction. There are no capital costs associated with the Rock Island Project.

Operation and maintenance costs for the Wells Project include hatchery operations and maintenance, bird hazing associated with the predator control program, administration of the gas abatement program, and other ongoing fish and miscellaneous studies (Figure F-4 [Appendix F]). For the Rocky Reach and Rock Island projects, operation and maintenance costs include those associated with the hatcheries, bypass operations (Rocky Reach Project), and predator

TABLE 4-5. POWER PRICING PARAMETERS USED TO CALCULATE ENERGY REPLACEMENT COSTS (IN 2002 DOLLARS)

MARGINAL PLANT PARAMETERS ¹	NATURAL GAS-FIRED COMBINED-CYCLE FACILITY COSTS	SINGLE-CYCLE COMBUSTION TURBINE		
Heat Rate, MMBtu/KWh	6,858	9,816		
Capital Cost, \$/MW	\$633,984	\$609,600		
Operation and Maintenance - Fixed, \$/MW/yr	\$10,871	\$0 ²		
Operation and Maintenance - Variable, \$/MWh	\$2.84	\$3.76		
Percent Capacity Factor	65%	4.5%		
Plant Life, years	30	30		

THE FOLLOWING ARE BLENDED COSTS					
\$2.64/mcf					
\$35.10/MWh					
\$22.19/MWh					
\$125,000/MW-year					

MW = megawatt me

mcf = thousand cubic feet

MWh = megawatt hour

³ The first year annual price is based on building and operating a combined-cycle combustion turbine and a single-cycle combustion turbine for the super peak periods. The power price includes both capacity and energy.

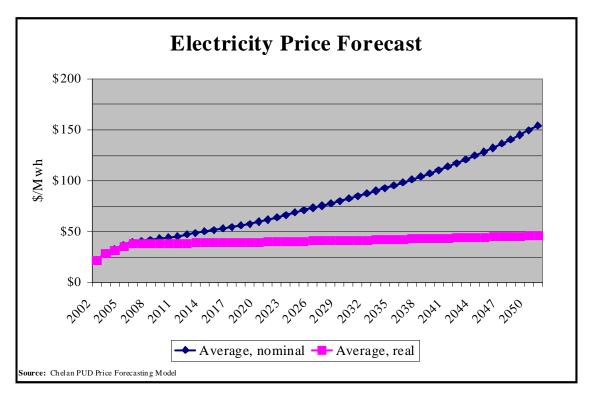


Figure 4-1. Electricity Price Forecast

¹ Northwest Power Planning Council's proposed new resource assumptions for the 5th Power Plan, April 2002.

² Costs are variable and included under operation and maintenance costs.

control programs (Figures F-5 and F-6 [Appendix F]). Total costs (including capital, operations, and maintenance) are provided in Table 4-6, including foregone power revenues using the three economic measures.

Spill under Alternative 1 is considerably less than under the other alternatives, resulting in the least amount of energy loss and a lower need for capacity replacement (Figures F-7 through F-15 [Appendix F]). Monthly energy loss does not correlate directly with the monthly spill because there is more energy loss during peak flow months (May through July) due to the increased river flow. Capacity replacement varies from energy loss based on fuel supply limitations and the ability to replace the lost energy. The analysis assumes that energy and capacity would be replaced by a natural gas-fired combined-cycle combustion turbine with an 85 percent capacity factor and a 7.0 percent reserve requirement (WECC guidelines used by Northwest Power Pool for thermal power plants). For example: replacement capacity = (MW capacity loss/ capacity factor) * (1 + reserve requirement).

4.8.3 ALTERNATIVE 2

Alternative 2 capital costs are greater than Alternative 1 for the Rocky Reach and Rock Island projects and are equivalent for the Wells Project (Figures F-1 through F-3 [Appendix F]). This is due to the Rocky Reach sluiceway capital costs and the gas abatement costs associated with increased spill for the Rock Island Project.

Operation and maintenance costs are also more expensive under Alternative 2 compared to Alternative 1. The additional costs include an increased predator control program for the listed species for all three projects, the sluiceway operations for the Rocky Reach Project, and the additional hatchery costs associated with the Rock Island Project.

Spill is the primary factor affecting energy loss and capacity replacement, and is significantly higher and for more months of the year under Alternative 2 than the other alternatives. Alternative 2 would result in the greatest energy losses and capacity replacement requirements for all three projects. The maximum losses would occur primarily in May and June and the lowest losses would occur in September and March (refer to Figures F-10 through F-15 [Appendix F]).

Over the next 50 years, the cost of implementing Alternative 2 ranges from 300 to over 500 percent greater than implementing Alternative 1, considering net present value as shown in Table 4-6.

Costs of reservoir drawdown were projected using the net present value of foregone power revenues. For a year-round reservoir drawdown, the estimated net present value of foregone power revenues would be \$3.9 billion for Wells, \$5.0 billion for Rocky Reach, and \$2.7 billion for Rock Island over the 50-year analysis period.

For a seasonal reservoir drawdown to the crest of the spillway, costs would be \$2.1 billion for Wells, \$2.9 billion for Rocky Reach, and \$1.6 billion for Rock Island. This latter estimate is based on 100 percent loss of energy and capacity for 6 months (March 15 through September 15) over the 50-year analysis period.

4.8.4 ALTERNATIVE 3

Capital costs associated with Alternative 3 include funding for the initial Plan Species Account and additional fish studies for the Wells Project and additional hatchery costs for the Rocky Reach and Rock Island projects (with hatchery costs greater for Rock Island than Rocky Reach). Alternative 3 capital costs are greater than costs for the other alternatives for the Wells Project due to the initial funding cost of the Plan Species Account. For the Rocky Reach Project, Alternative 3 is less than Alternative 2 due to the higher sluiceway costs associated with Alternative 2. For the Rock Island Project, Alternative 3 costs are less than Alternative 2

because mitigation costs associated with dissolved gas would not be needed.

Operation and maintenance costs are higher for Alternative 3 than for the other alternatives for all three projects. These additional costs include an increased predator control program, additional fish studies associated with the evaluation monitoring, HCP committee costs, Plan Species Account payments, and additional hatchery costs.

Spill is generally higher under Alternative 3 compared to Alternative 1 but substantially lower than under Alternative 2 (Figures F-7 through F-9 [Appendix F]). Spill may vary by year for Rocky Reach dependent on the effectiveness of the bypass (Figure F-8). If the evaluation studies verify that the bypass facility is successful in helping to meet the no net impact standard for

juvenile fish, then the amount of spill can be reduced.

The energy loss and capacity replacement needs are generally greater for Alternative 3 compared to Alternative 1, but substantially less than under Alternative 2 for all projects. Implementation of Alternative 3 would result in a 20 to 85 percent increase in project costs over Alternative 1, with the least increase (20 percent) associated with the Wells Project and the greatest increase (85 percent) associated with the Rock Island Project.

Drawdown costs associated with Alternative 3 would be similar to those described under Alternative 2.

TABLE 4-6. SUMMARY OF COSTS (IN MILLIONS) AND FOREGONE POWER REVENUES

	PROJECT COSTS OF IMPLEMENTING FISH CONSERVATION MEASURES ¹										
	WELLS			ROCKY REACH			Rock Island				
	ALT 1	ALT 2	ALT 3	ALT 1	ALT 2	ALT 3	ALT 1	ALT 2	ALT 3		
Net Present Value ²											
Costs	\$79	\$82	\$90	\$237	\$358	\$261	\$103	\$101	\$95		
Foregone Power Revenues	\$77	\$785	\$98	\$155	\$1,116	\$250	\$67	\$587	\$221		
TOTAL	\$156	\$867	\$188	\$392	\$1,474	\$511	\$170	\$688	\$316		
Levelized Value ³											
Costs	\$6	\$6	\$7	\$17	\$26	\$19	\$7	\$7	\$7		
Foregone Power Revenues	\$6	\$57	\$7	\$11	\$81	\$18	\$5	\$43	\$16		
TOTAL	\$12	\$63	\$14	\$28	\$107	\$37	\$12	\$50	\$23		
First Year Value ^{4,5}											
Costs, levelized	3	3	4	11	16	12	4	4	4		
Foregone Power Revenues	3	35	4	7	50	15	3	24	9		
TOTAL	6	38	8	18	66	27	7	28	13		

¹ Not including reservoir drawdown.

² Net present value is the discounted value today of the future values using a given discount rate.

³ Levelized value is the constant stream of values, using a given interest rate, that produces the same net present value as the non-constant stream of values (if future values change over time).

⁴ First year values are the costs and foregone power revenues incurred in the first year of the 50-year analysis period.

⁵ This approach is consistent with FERC's approach to economic analysis (Mead Corporation, Publishing Paper Division, 72 FERC 61,027 [July 13, 1995]), where the power losses of the alternatives are equated to the current (2002) amount that would be paid for the same amount of power produced by alternative resources. The current year approach compares the alternatives without the effects of inflation or escalation on the costs or foregone power revenues.

4.9 AESTHETICS

4.9.1 ALTERNATIVE 1 (No-ACTION)

4.9.1.1 Project Area

Under Alternative 1, existing fish mitigation and compensation measures for all three dams would continue. Continued operation, maintenance, and planned facility upgrades for the fishways and associated entrances, fishladders, bypass systems (collection entrances and intake screens), turbines, and hatcheries associated with the three dams would not result in any changes to the aesthetics in the areas of the three dams because these facilities are primarily located within the water column or subordinate to the projects' dominant concrete features.

4.9.1.2 Associated Tributaries

No PUD-funded improvements would occur in the tributaries under Alternative 1. However. over the next 50 years, habitat restoration within the Wenatchee, Entiat, Methow, and Okanogan watersheds would occur from ongoing WRIA projects being funded through various Federal, State, and local funding sources that are aimed at helping restore salmon and steelhead runs in the Mid-Columbia River system. The USFS would also continue to support local projects to improve stream conditions for salmonid habitat on National Forest land. Short-term constructionrelated effects to the aesthetics of the area could result from these fish habitat enhancement projects within the tributaries (such as culvert modifications and projects that may require temporary roads for site access), but no long-term or permanent detrimental effects to the aesthetics of the area would occur under Alternative 1.

Overall aesthetic effects from these projects would be improvements in the appearance of natural conditions. The hydroelectric project operations would not affect these efforts or the aesthetic conditions along the tributaries.

4.9.2 ALTERNATIVE 2

4.9.2.1 Project Area

Under Alternative 2, the fish mitigation and compensation measures described under this alternative would occur, and an increase in spill would occur at any or all of the three dams as needed to prevent the extinction of listed species. In addition, FERC may order drawdown, which would result in exposure of more shoreline. The effect of the increased shoreline exposure on aesthetics in the area would depend on the amount of increased drawdown and the length of time the drawdown would remain in effect.

Drawdown would expose substantial amounts of barren shoreline, which in general is not appealing to tourists and visitors of the area, as described under Section 4.10, Recreation.

However, provided that FERC orders a permanent drawdown of the reservoirs, over time, new vegetation would become reestablished along the exposed shoreline. Therefore, the negative effects on aesthetics would be reduced over time as barren and exposed shorelines are revegetated. This impact would not occur under Alternative 1.

4.9.2.2 Associated Tributaries

Alternative 2 is not expected to affect aesthetics in the tributary areas, and therefore effects to aesthetics would be the same as described under Alternative 1.

4.9.3 ALTERNATIVE 3

4.9.3.1 Project Area

The effects of Alternative 3 to the aesthetic conditions of the project area are similar to Alternatives 1 and 2, which is negligible. The

proposed project improvements to increase fish survival would not noticeably alter visual conditions in the project area. However, drawdown could occur under either Alternatives 2 or 3. Aesthetic effects from drawdown are described under Alternative 2, and predominantly consist of exposed shorelines that lack vegetation. If permanent drawdown occurs, the barren shorelines would become vegetated over time, and it is likely that efforts would be made to plant native vegetation in these areas.

4.9.3.2 Associated Tributaries

The actions associated with Alternative 3 at the project sites (the dams and reservoirs) would have no effect on the aesthetic resources located at the tributaries. Similar to Alternatives 1 and 2, WRIA habitat restoration projects would occur along the four tributaries. Alternative 3 would help to increase funding for habitat restoration beyond that provided by the WRIA-funded or other voluntary efforts to conserve, restore, and enhance salmonid habitat in the tributaries. Consequently, long-term effects to the aesthetics

in the areas of the associated tributaries would be improved through the provision of the Plan Species Account funds.

These efforts would include the purchase of water rights and land, with subsequent habitat restoration. The development of conservation easements for the protection of critical riparian areas and spawning and rearing habitat would help to preserve native vegetation and natural conditions along the tributaries. An expected increase in public use and viewing of fish and wildlife would likely occur over the long term. The fencing of livestock supported by the Plan Species Account along riparian areas would further enhance the natural beauty of the tributary streams.

In the short term, some construction-related effects from restoring riparian and stream habitat could negatively impact tributary aesthetics in specific areas. Some construction equipment may require vegetation removal for access to specific shoreline areas. However, over the long term, these effects would decrease as vegetation becomes restored in the construction areas.

4.10 RECREATION

4.10.1 ALTERNATIVE 1 (No-ACTION)

4.10.1.1 Project Area

Under the current licenses and amendments, including the recreation plan (Wells: FERC 1962a,b, 1982; Rocky Reach: FERC 1953, 1957a,b, 1976; Rock Island: FERC 1975a, 1987a, 1989a), there would be no effect on recreational facilities or opportunities, other than recreational fishing, from construction and implementation of fish passage improvement measures. Implementation of fish passage improvements is designed to have a beneficial effect on the survival rate of anadromous fish, and therefore could result in an improvement to salmonid fisheries. The fish passage

improvement measures are not expected to have a significant effect on resident fish. The recreation plans for the projects are updated every 5 years and can be revised to accommodate changing recreational needs.

4.10.1.2 Associated Tributaries

Although no changes are expected to occur to recreational facilities within the project area, recreational access and facilities could be affected by the ongoing WRIA projects and watershed action plans in each of the tributaries over the next 50 years. These projects may decrease some recreational use in the tributaries through purchase of shoreline easements for fish habitat protection and restoration.

4.10.2 ALTERNATIVE 2

Under Alternative 2, protective measures that would be implemented in the near term include modifications to equipment at the dams and an increase in spill. Recreational use in the immediate vicinity of the dams is limited to shoreline activities.

4.10.2.1 Project Area

For planned and known actions that would occur under Alternative 2, there would be few, if any, changes to recreational activities or facilities due to structural improvements or modifications. At all three dams, existing fishways, ladders, and bypass systems would continue in operation and be maintained to increase efficiency. Similar to Alternative 1, none of the actions associated with Alternative 2 would affect recreation, except for potential brief closures of public viewing areas near the structures during project construction.

Over the long term, the most substantial action that could potentially occur would be drawing down any or all of the projects to natural river levels. This action could have substantial effects on recreation. Without modifications, the lower water levels would render boat ramps, docks, and beaches unusable from April through August when peak recreational activity occurs. This would be a substantial loss of recreational facilities, and if not modified, could potentially affect a large number of users. The lower water level would also indirectly affect recreation by reducing the aesthetic qualities of the waterfront areas. The lowered pool would expose an unvegetated area of silt, sand, and rock. The loss

of aesthetic quality could result in substantially lower recreational activity, until the shoreline areas were revegetated.

Effects to recreation from drawdown at the Wells reservoir would occur to Pateros Memorial Park, Pateros Peninsula Park, Brewster Columbia Cove Park, Brewster Waterfront Trail, and Bridgeport Marina Park. Instead of waterfront settings, the parks would instead front an expanse of silt, sand, and rock. There are five public parks located near the Rocky Reach reservoir (Lincoln Rock State Park, Orondo State Park, Daroga State Park, Entiat Park, and Beebe Bridge Park) that would be affected by drawdown. In addition to the loss of the boat ramps and beaches, the lower water levels would also have aesthetic effects that would indirectly reduce recreational activity.

Effects from drawing down the Rock Island reservoir would be low to moderate. In the Wenatchee River, the potential change of 2.5 feet would probably not cause substantial aesthetic effects to views from Riverfront Park. Parks affected near the Rock Island reservoir include Riverfront Park, Wenatchee Confluence State Park, and Rock Island Hydro Park. The boat ramps and beaches would not be usable, unless modified. These effects would not occur under Alternative 1.

The loss of recreational opportunity and setting would result in a corresponding loss in recreation expenditures, employment, and tax revenues, at least in the near term. Recreational expenditures are important to Chelan and Okanogan counties, but many of the recreational opportunities are located in mountain and upland settings away from the project area and would not be affected. Of the 80 total boat launches in Okanogan County, only the five launch lanes located in Pateros Memorial Park, Brewster Columbia Cove Park, and Starr Boat Launch would be affected. In Douglas County, relatively more facilities could be affected (for example, 14 of 15 total boat launch lanes). These effects would not occur under Alternative 1.

² The total number of visitors to parks in the project area is known. However, data that distinguish between water-dependent uses (such as boating, fishing, and swimming) and non-water-dependent uses (such as picnicking or camping) are not available. Therefore, the number of recreational users that would be affected cannot be calculated.

If drawdown were to occur, there would be an increase in recreational fishing opportunities for coldwater fish (such as trout) that prefer free-flowing river habitat, and a decrease in fishing opportunities for warmwater fish (such as bass and walleye) that prefer reservoir habitat, in comparison to Alternative 1.

4.10.2.2 Associated Tributaries

Effects to recreation sites and fishing opportunities are similar to Alternative 1. Habitat improvements proposed under the WRIA projects and other action plans could temporarily affect some recreational activities along project tributaries. Access for fishing may be restricted over the short term while improvements are constructed, and possibly for a short time thereafter to allow vegetation to become reestablished. These restrictions would be temporary and probably would not last more than one season. The overall effect would not be substantial.

Over the long term, non-PUD funded habitat improvements in the tributaries would probably benefit other game fish, such as trout. This would improve recreational fishing opportunities and indirectly benefit the local economies. These benefits would occur under both Alternative 1 and 2.

4.10.3 ALTERNATIVE 3

4.10.3.1 Project Area

The protective measures planned under Alternative 3 would have no effect on recreational activities or facilities in the project area other than recreational fishing. Similar to Alternative 2, modifications and improvements to improve fish passage would not alter recreational use (except for brief closures of public viewing areas during construction), and are designed to have a beneficial effect on the survival rate of anadromous fish. Therefore, the protective measures planned under Alternative 3 could result in improvements to the spring-run chinook, summer/fall chinook, and sockeye salmon and steelhead fisheries, in addition to improvements that would occur under Alternatives 1 and 2.

Outside of drawdown, pool level fluctuations under Alternative 3 at the three reservoirs would continue to be similar to existing conditions (Alternative 1). Stable and predictable water levels generally benefit recreational users and fishing residents, and would not affect recreational facilities. However, drawdown, a possibility under Alternative 3, would result in recreational impacts as described under Alternative 2. These include loss in use of recreational facilities and opportunities associated with shoreline access.

4.10.3.2 Associated Tributaries

Tributary habitat improvement projects funded through the Plan Species Account would likely result in increased recreational benefits to tourists and residents in the area. An increase in recreational access may occur through the expansion of public lands and fishing opportunities from new conservation easements and the public purchase of private lands. Passive recreational benefits may occur, such as increased opportunities to view native restored riparian habitats. Some of these benefits would also occur through WRIA and other volunteer efforts, but the benefits would be greater through the additional funding provided by the Plan Species Account.

4.11 CULTURAL RESOURCES

In general, cultural resources must be at least 50 years old to be eligible for the nation's inventory

of historic places, known as the National Register of Historic Places (National Register). The types

of properties listed in the register include archaeological sites and buildings and structures, as well as traditional cultural properties or places that are associated with a community's historically rooted beliefs, customs, and practices. Cultural resources dating to the last 50 years do not meet the National Register criteria unless they are of exceptional importance. This exception is described in the National Park Service Bulletin No. 22, *Guidelines for Evaluating and Nominating Properties That Have Achieved Significance Within the Last 50 Years* (Sherfy and Luce 1998).

The National Historic Preservation Act and NEPA require the consideration of historic resources prior to implementing projects affecting the environment. Section 106 of the National Historic Preservation Act requires that projects with Federal involvement take into account the effects such actions would have on properties that are listed in or eligible for the National Register. The NEPA indicates that it is the "responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs and resources to the end that the Nation may... preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice."

The following sections address the effects that the alternatives would have on properties eligible for the National Register and provide mitigation measures for potential effects. An adverse effect occurs to cultural resources when the characteristics that make a property eligible for the National Register are diminished or destroyed. An adverse effect also occurs when an undertaking causes irreversible damage or destruction to a historic site or its setting. The area of potential effect, or geographic area within which the proposed project may affect cultural resources, includes the dams themselves and the

reservoirs behind Wells, Rocky Reach, and Rock Island dams, and portions of the Wenatchee, Entiat, Methow, and Okanogan drainage basins.

4.11.1 ALTERNATIVE 1 (No-ACTION)

4.11.1.1 Project Area

Wells Dam

Under the current license (1963) and amendments (1982), there would be no new effects to cultural resources. As outlined in Chapter 3, data recovery occurred in 1982 to mitigate for the inundation of 13 National Register-eligible archaeological sites. Additional archaeological sites adjacent to the reservoir could be exposed due to ongoing natural processes and human use of the reservoir, such as erosion, vandalism, artifact collection, and vehicle use across archaeological sites. Because no historically significant buildings or structures are located within the study area, there would be no ongoing potential effects to buildings and structures. Under the current license, the Douglas County PUD has developed a Memorandum of Agreement with the Colville Tribes and the State Historic Preservation Office to address such effects

Rocky Reach Dam

Under the current license for Rocky Reach Dam, no new effects to cultural resources are anticipated. The ongoing effects caused by natural processes and human actions noted in the previous discussion for Wells Dam could also affect cultural resources within the Rocky Reach Dam study area. As described in Chapter 3, the current Rocky Reach Dam license issued in 1957 originally included minimal stipulations regarding the management of cultural resources. In 1983, the license was amended to include Article 49, which designates protection measures, including consultation with the State Historic Preservation Officer regarding construction projects that could

affect cultural resources. As part of Chelan County PUD's relicensing of the Rocky Reach Dam, the PUD would develop a cultural resource management plan. This plan would be reviewed and approved by FERC, affected Tribes, and the State Historic Preservation Officer.

Rock Island Dam

No new effects are anticipated under the current license for the Rock Island Dam, issued in 1989. Under this license, the Chelan County PUD created a cultural resource management plan to address the management of cultural resources associated with the project, which was reviewed and approved by FERC, affected Tribes, and the State Historic Preservation Officer. The ongoing effects due to natural processes and human use that are listed in the previous discussion for Wells Dam also apply to Rock Island Dam. Under the current license, such effects would be addressed according to management processes stipulated in the cultural resource management plan.

4.11.1.2 Associated Tributaries

Independent tributary enhancement projects may affect cultural resources along the shorelines of the four tributaries. However, these projects are likely to require environmental review and permitting that would ensure that cultural resources are protected during construction and over the long term. The applicant and lead agency for these projects would be required to conduct this environmental review. Ongoing dam operations would have no effect on cultural resources within the tributaries.

4.11.2 **ALTERNATIVE 2**

4.11.2.1 Project Area

Wells Dam

The Wells Dam was constructed in the 1960s and does not appear to possess the exceptional significance necessary for properties less than 50 years old to be listed in the National Register. Therefore, the previously described modifications to the dam would not affect a historic structure. In addition to modifications to the dam, Alternative 2 includes the implementation of management procedures, such as developing solutions to improve fish passage and operating the surface bypass system 24 hours per day to encourage migration of spring-run chinook salmon and steelhead. These actions would not involve noticeable fluctuations in water levels or ground disturbances that would affect cultural resources. Similar to Alternative 1, there would be no effect to cultural resources at the project sites from implementation of Alternative 2.

Prior to the inundation of the Wells reservoir in the 1960s, archaeologist G.F. Grabert identified numerous prehistoric sites along the historic shoreline of the Columbia River. Grabert also identified and excavated the archaeological remains of Fort Okanogan, the American Pacific Fur Company fort established in 1811 at the confluence of the Columbia and Okanogan Rivers (Grabert 1968b). A subsequent study of the Wells reservoir area reported on 23 prehistoric archaeological sites, some of which had been previously identified (Chatters 1986).

Unlike conditions under Alternative 1, NMFS has the authority under Alternative 2 to request any protection measures that would assist in the survival of endangered salmon and steelhead species, including the potential drawing down of reservoir waters to alter river flow. The fluctuation in water levels caused by drawing down the reservoir could affect sites along the

shoreline and other sites that are currently inundated by the reservoir. Alternating wet and dry conditions could cause the deterioration of organic material found in these archaeological sites. Wave action and fluctuations in water levels may also cause erosion to archaeological sites, and artifact collectors could be attracted to exposed sites. If NMFS requires reservoir drawdown, actions to protect cultural resources would be included in the operational constraints of the project.

Rocky Reach Dam

Under Alternative 2, the on-site protection measures for adult and juvenile passage in the Rocky Reach Dam area would be similar to those listed for the Wells Dam. The Rocky Reach Dam, constructed in the 1960s, does not appear to possess the exceptional significance necessary for properties less than 50 years old to be listed in the National Register. Therefore, the previously described modifications to various components of the dam would not affect a historic structure.

In addition to modifying components of the Rocky Reach Dam, Alternative 2 involves the introduction of new management measures, such as developing corrective actions for adult fish passage, if necessary, and utilizing a 24-hour per day spill plan to encourage juvenile passage. Such management actions would not create noticeable fluctuations in water levels or ground disturbances that would affect archaeological sites, buildings, structures, or traditional cultural properties eligible for listing in the National Register.

Prior to the inundation of the Rocky Reach reservoir in the 1960s, Washington State University surveyed the flood zone and identified the remains of pithouses, resource procurement camps, and shell middens. A subsequent study of the reservoir conducted by Washington State University in 1983 located similar site types. Neither study identified prehistoric village sites in the area. The later study concluded that the area's

apparent absence of village sites could be a result of the local topography, which lacked an easily accessible fishery. Although it is doubtful that undiscovered prehistoric village sites are located in this area, it is possible that additional small camps and resource procurement sites are located within the Rocky Reach Project area. Historic period activities such as exploration, fur trapping, homesteading, and ranching may have occurred in this area, and historic period archaeological sites are also located in this area.

If NMFS requires drawing down the Rocky Reach reservoir for the protection of endangered species, effects could occur to prehistoric and historic archaeological sites. Effects to the Rocky Reach Project area would be similar to those listed for the Wells Project area. However, actions to protect cultural resources would be included in the operational constraints of the project. In conclusion, effects from Alternative 2 are similar to those of Alternative 1, excepting impacts that could occur under drawdown, which would not occur under Alternative 1.

Rock Island Dam

Alternative 2 would improve adult and juvenile fish passage in the Rock Island Dam project area by using measures similar to those listed for Rocky Reach Dam, along with improved fishway efficiency created by maximizing the number of adult migrants that enter the facilities. Juvenile passage through non-turbine routes (e.g., spill), while minimizing the production of total dissolved gas.

Constructed in 1933, the Rock Island Dam was the first hydroelectric dam on the Columbia River. A 1988 National Register evaluation of the structure determined that modifications have rendered the dam ineligible for the National Register. The National Register form indicates that, "the components of the dam installed between 1930 (when actual work began at the site) and 1936 (when the center fishladder was added) have all been altered virtually beyond

recognition, with the exception of the downstream wall and front façade of Powerhouse 1" (Holstine 1988). Because the dam is ineligible for the National Register, changes to dam features, such as ladder modifications, would not affect a historic resource.

In addition to minor modifications to components of the Rock Island Dam, Alternative 2 includes a new management program, such as modeling to correct delay problems and operating the spillway to facilitate the movement of different fish species. These measures would not result in noticeable changes in water levels or ground disturbances that could affect archaeological sites, nor would such actions affect historic buildings and structures or traditional cultural properties.

Prehistoric and historic archaeological sites are commonly found near natural sources of water. As noted in Section 3.11, Cultural Resources, a comprehensive study of the Rock Island Dam reservoir identified prehistoric hunting, fishing, and village sites in the study area (Lothson et al. 1982). Historic period activities such as exploration, fur trapping, homesteading, ranching, and hydroelectric development may have also left historic archaeological sites in the project area. Therefore, additional undiscovered prehistoric and historic sites could be located within the project area.

If the status of endangered species requires NMFS to drawdown the Columbia River, currently inundated sites located within the reservoir could be exposed. In this instance, the Rock Island Dam project area has the potential of experiencing the same effects to archaeological resources as the Wells Dam. However, actions to protect cultural resources would be included in the operational constraints of the project. In conclusion, effects to cultural resources under Alternative 2 are similar to Alternative 1, except for additional impacts that would occur with the drawdown scenario.

4.11.2.2 Associated Tributaries

Alternative 2 is not expected to affect cultural resources in the tributary areas; therefore, effects to cultural resources would be the same as under Alternative 1.

4.11.3 ALTERNATIVE 3

4.11.3.1 Project Area

Wells Dam

Because the Wells Dam does not appear to be historically significant, potential modifications to the dam (such as altering fishladders) would not affect a historic resource. These results are the same as under Alternatives 1 and 2. As noted in Section 3.11, Cultural Resources, the Wells Dam includes numerous archaeological sites (Chatters 1986; Grabert 1968a). This alternative would not include ground disturbance or fluctuation of water levels that could affect archaeological sites. Drawdown effects are as described under Alternative 2.

Rocky Reach Dam

Because the Rocky Reach Dam does not appear to be historically significant, modifications to the dam, such as the addition of a turbine bypass system and turbine runners, would not affect a historic property. These results are the same as under Alternatives 1 and 2. As noted in Section 3.11, Cultural Resources, prehistoric and historic archaeological sites are located within the Rocky Reach Dam project area, primarily in the vicinity of the reservoir. None of the previously described actions associated with Alternative 3 would result in ground disturbance or increased fluctuations of water levels. This alternative would therefore not affect resources eligible for listing in the National Register. Drawdown effects are similar to that described under Alternative 2.

Rock Island Dam

Because alterations to the Rock Island Dam have rendered it ineligible for the National Register, the addition of a turbine bypass system and other such modifications to the dam would not affect a historic resource. These results are the same as under Alternatives 1 and 2. As noted in Section 3.11, Cultural Resources, previous archaeological surveys have identified prehistoric and historic archaeological sites located within the Rock Island Dam project area. Because the operational modifications associated with Alternative 3 would not result in ground disturbance or increased fluctuation of reservoir water levels. effects would not occur to cultural resources eligible for listing in the National Register. Drawdown effects are similar to that described under Alternative 2.

4.11.3.2 Associated Tributaries

Alternative 3 would involve habitat enhancement of the tributaries leading into the Wells, Rocky Reach, and Rock Island reservoirs. These enhancement projects are in addition to those WRIA-funded projects that would occur independent of project alternatives. The tributaries affected by this action include the Wenatchee, Entiat, Methow, and Okanogan Rivers. Specific effects to resources located on or near the different tributaries have been listed below for each watershed. Rather than detailing all habitat restoration measures for each area, this section identifies specific measures that could potentially affect historic resources.

National Register-eligible archaeological sites, historic structures, and traditional cultural properties could experience effects due to proposed tributary enhancements. As described in Section 3.11, Cultural Resources, prehistoric use of the tributary areas could have resulted in the development of domestic archaeological sites, as well as resource processing stations for fish, mammals, birds, and plants. Archeological sites could also include campsites, burials, isolated

finds, fire hearths, petroglyphs, and trails. Historic period remains within the tributary areas may be associated with fur trading, mining, logging, settlement, and farming. Historic period properties could consist of archaeological sites and structures such as irrigation canals, culverts, and old logging dams. Cultural resources within the tributary areas could also include plants important for Native American subsistence, spiritual, and medicinal purposes and traditional cultural properties identified by Tribes (Hanes 1995).

Wenatchee Watershed

The habitat restoration measures proposed for the Wenatchee watershed would improve the stream channel and floodplain conditions. Restoration measures may involve restoring floodplain function with the addition of vegetation along the river, altering diversion points to increase instream flows, reestablishing fish passage to wetlands currently cut off by Highway 2, developing riparian habitats in rights-of-way along highways, modifying diversion dams to encourage anadromous fish passage to Upper Icicle Creek, altering specific culverts to enhance the passage of anadromous salmonids, and restoring the mouth of Deep Creek and portions of Icicle Creek. Most of these actions would involve ground disturbance through such activities as planting vegetation along riverbanks or reestablishing access to wetlands by digging channels. Effects could occur to archaeological sites and traditional cultural properties located within the areas where restoration projects would be implemented. Historic structures, such as irrigation canals and culverts, could also undergo effects due to the tributary habitat restoration program in the Wenatchee watershed.

Entiat Watershed

Within the Entiat watershed, proposed restoration measures focus on enhancing the stream channel and floodplain to encourage fish development. Restoration would include improving fish habitat with the addition of boulders and wood debris to increase the number of pools in the river, revegetation along the lower reach of the Entiat River, and potential changes in the levels of water used by local irrigators. Depositing boulders and wood debris in the river is likely to disturb soils adjacent to the river with the use of heavy equipment along the riverbank. Other restoration measures, such as revegetation, would disturb soils and potentially effect archaeological resources or traditional cultural properties located within the study area. Historic structures, including irrigation canals and culverts, could also undergo effects due to this action. Fluctuating water levels caused by changing water use by irrigators could expose archaeological sites and lead to site erosion and unauthorized artifact collection.

Methow Watershed

The proposed Methow watershed restoration plan includes purchasing conservation easements, water rights, and land in critical spawning and rearing sites located throughout the Methow Valley. In addition, efforts would be pursued to restore riparian vegetation through livestock fencing and revegetation programs, restoring the side channel reaches of the watershed, and restoring riparian habitat on Lower Libby and Gold Creeks and on the Lower Twisp and Chewuch Rivers. These activities would likely be funded through the Plan Species Account. If these activities are funded through the Plan Species Account, effects could include minor ground disturbances, with subsequent effects on archaeological sites, traditional cultural properties, and historic structures.

Okanogan Watershed

In the Okanogan watershed, proposed habitat restoration measures focus on improving stream channel and floodplain conditions along the mainstem of the Okanogan River, restoring anadromous salmonid passage in Salmon and Omak Creeks and into Skaha Lake, revegetating and stabilizing portions of the Okanogan River bank, revegetating denuded portions of the Lower Similkameen River, revegetating the middle Similkameen River if fish passage is restored in this river, revegetating and stabilizing portions of the erosive banks on the Okanogan River between Bonapart and Omak Creeks, and adding rock structures at selected locations in the watershed to enhance spawning habitat. Each of these actions has the potential of creating ground disturbances that would affect archaeological resources, traditional cultural properties, and historic properties.

Alternative 3 includes tributary habitat enhancement activities funded by the PUDs. As noted previously, habitat enhancement could include disturbances to shoreline areas where prehistoric and historic archaeological sites are commonly found. To limit effects to archaeological sites, an archaeological survey would likely be required by the permitting agency. To assist in planning the survey and evaluating archaeological sites and historic properties, the entities responsible for implementing these projects would contact the Washington State Archaeologist and the affected Indian Tribes. A Washington State archaeological inventory form would be prepared for each site identified during the survey and submitted to the Office of Archaeology and Historic Preservation for a formal determination of National Register eligibility. In consultation with the State Archaeologist and the affected Indian Tribes, the implementation entity would assess the effect any project would have on any sites eligible for the National Register.

Mitigation measures would be developed for each National Register-eligible property that would be affected by the proposed tributary enhancement project. Mitigation measures could include excavation of archeological sites or stabilizing sites by covering them with fill. Historic properties would be documented to the standards

of the National Park Service's Historic American Building Survey/Historic American Engineering Record.

The tributary enhancement revegetation and floodplain development could result in exposed archaeological sites. As mentioned previously,

increased artifact collection can occur when sites are exposed. To limit collection, a program would be developed to monitor exposed archaeological sites. This would be required to be conducted by the project applicant responsible for the project.

4.12 ENVIRONMENTAL JUSTICE

Executive Order 12898 (59 Federal Register 76299, 1994) directs Federal agencies to identify and address, as appropriate, any disproportionately high and adverse human health or environmental effects on minority populations and low-income populations.

None of the alternatives would affect human health of any population located in the vicinity of the projects. The conservation measures included in each of the alternatives would not affect pollutants or prey consumed by fish and, therefore, human health would not be impacted under any alternative.

4.12.1 ALTERNATIVE 1 (No-ACTION)

Alternative 1 would not affect minority employment regarding hydroelectric operations in the project area. Although minorities are regularly hired by Chelan and Douglas County PUDs, minorities do not constitute a substantial portion of the employment force for ongoing fish studies, hatchery operations, or other project operations or maintenance. No change is expected in minority populations in the project area relative to ongoing hydroelectric operations. However, it is likely that fishing success and/or fishing opportunities may decrease without additional conservation measures aimed at increasing salmon survival in the Columbia River. Decreases in fishing opportunities would affect those minority populations employed in fishing, as well as subsistence harvest. As described in Section 3.7.4, Tribal Economies, agriculture, fishing, and forestry constitute up to 8 percent of Tribal employment.

4.12.2 <u>ALTERNATIVE 2</u>

Similar to Alternative 1, minority employment regarding hydroelectric operations for conservation measures would not be affected under Alternative 2. Increased survival of listed salmonid species (and possibly for unlisted species if increased conservation measures for these species are agreed upon during relicensing), would be expected to increase salmonid populations, which would aid in fishing success and may help to increase overall fishing opportunities in the Columbia River.

If drawdown were to occur under Alternative 2, the loss of irrigation water for agriculture would affect minority employment, with an expected decrease in the number of agricultural jobs available in the three-county area. The minority populations in the three-county area that rely on agricultural employment would likely be displaced and would leave the area in search of employment elsewhere. Thus, the overall minority population may decrease, as well as the number employed and their overall income. The effect from drawdown on minority populations would be evaluated in a separate NEPA analysis because of its substantial and potentially adverse effect on the human environment. Unlike conditions under Alternative 2, these population and employment effects would not occur under Alternative 1.

Hatchery operations also have the potential to impact naturally spawning populations (see Section 2.3.2.4, Interaction Between Hatchery Stocks and Wild Stocks) and consequently,

NMFS could require a reduction in hatchery production as a result of Endangered Species Act consultation for any hatchery species. This reduction would likely affect Tribal harvest and subsistence fishing success and opportunities, as well as fishing opportunities for any minority or low-income persons accustomed to fishing in this area. This impact would be offset to the extent that protective measures would be successful in increasing the number of naturally produced spawners. This impact would not occur under Alternative 1.

4.12.3 <u>ALTERNATIVE 3</u>

Effects under Alternative 3 would be similar to Alternative 2 in that the fish conservation measures associated with Alternative 3 would likely result in increased fishing success and opportunities. Similarly, in the case of drawdown, minorities employed in agriculture would likely have a loss in employment.

Alternative 3 would likely increase fishing opportunities and success for unlisted salmon species compared to Alternatives 1 and 2 because the conservation measures associated with Alternative 3 include both Endangered Species Act-listed and unlisted species.

A reduction in hatchery operations under Alternative 3 could not occur until at least 2013, and would subsequently be reviewed every 10 years to determine effects of hatchery production on wild fish. During these reviews, NMFS could require a reduction in hatchery production. This contrasts with Alternative 2, where the hatchery review and a potential decrease in hatchery production could occur at any time over the next 50 years, and Alternative 1, where hatchery production would not decrease. As under Alternative 2, the impact of reduced hatchery production would be offset to the extent that protective measures would be successful in increasing the number of naturally produced spawners.

4.13 RELATIONSHIP TO LAWS AND POLICIES

This section addresses the State and Federal statutes, implementing regulations, and executive orders that potentially apply to the alternatives considered in this EIS. It also considers the relationship of alternatives with State laws, Tribal treaties and settlements, and U.S. treaties. The environmental effects analysis discussed in this section provides the primary basis for the conclusions on compliance with environmental laws.

4.13.1 NATIONAL ENVIRONMENTAL POLICY ACT

This EIS was prepared pursuant to regulations implementing the NEPA (42 USC 4321), and in compliance with Federal regulations for preparing an EIS (40 CFR 1502). This EIS considers three alternatives, provides required discussions and analysis, and includes results of public meetings,

public scoping, coordination, and opportunities for comment. Section 1.5, Regulatory Framework, provides additional information on regulatory requirements and processes.

4.13.2 FEDERAL POWER ACT

The Federal Power Act provides FERC with the exclusive authority to license non-Federal water power projects on navigable waterways and Federal lands. During relicensing for each project, FERC decides (1) whether to issue the license to an applicant, and (2) the conditions that should be placed on the license to protect or enhance existing environmental resources. FERC considers the project's consistency with Federal and State comprehensive plans for improving, developing, or conserving the waterway. FERC weighs competing interests, including both power and non-power uses, to ensure a proper balance.

As part of its licensing responsibilities, FERC complies with the Endangered Species Act and the Clean Water Act.

The fish protection measures developed under the action alternatives would comply with NMFS's responsibilities under Sections 10a, 10j, and 18 of the Federal Power Act, pertaining to anadromous fish protection.

4.13.3 PACIFIC NORTHWEST ELECTRIC POWER PLANNING AND CONSERVATION ACT

Congress passed the Northwest Power Act in 1980 (16 USC 829d), creating the Northwest Power Planning Council. The council's membership and programs are summarized in Section 1.5.2.5, Other Federal, State, and Local Requirements. The council is not a Federal agency and does not have regulatory control of Columbia River resources. Most of the programs under the council are funded by BPA revenues and do not directly involve the PUDs. Still, there are some programs that are related to the proposed action, and NMFS ensures that salmon and steelhead species conservation and recovery programs are consistent during their environmental review of the programs.

- The Council's Multi-Species Framework Project brings State, Federal, and Tribal governments together with stakeholders to review alternative approaches to fish and wildlife policy from a basinwide perspective. The project emphasizes restoring environmental conditions for multiple species through changes in river management and hydropower project operating policies. This EIS considers effects to the ecosystem in Sections 4.2, Fisheries Resources, through 4.5, Wildlife, and the HCP also takes an ecosystem approach that is consistent with the Council's multi-species strategy.
- The Fish Passage Center is part of the Council's Fish and Wildlife Program, and

provides the information basis for Federal, State, and Tribal recommendations for fish passage at Federal Columbia and Snake River hydroelectric projects. The alternatives considered in this EIS would involve continued coordination of their flow programs with the Center.

4.13.4 <u>TITLE 77 REVISED CODE OF</u> WASHINGTON

Title 77 addresses regulations and laws of WDFW. Pertinent Title 77 chapters relevant to the action alternatives include 77.15 Fish and Wildlife Enforcement, 77.16 Diversion of Water, 77.85 Salmon Recovery, and 77.95 Salmon Enhancement Program. Implementation of either Section 7 or Section 10 of the Endangered Species Act (Alternative 2 or 3) would meet WDFW's approval for fish protection measures of the five Plan species.

4.13.5 FISH AND WILDLIFE COORDINATION ACT

The Fish and Wildlife Coordination Act requires consultations with USFWS when any water body is impounded, diverted, controlled, or modified for any purpose by any agency under a Federal permit or license. The purpose of this act is to ensure that potential effects to fish and wildlife are identified and mitigated. Compliance with the Fish and Wildlife Coordination Act occurs through this EIS, through project licensing, and through the Endangered Species Act compliance activities incorporated in Alternatives 2 and 3.

USFWS has been continually advised or consulted with during the HCP and EIS development process. The DEIS comments from USFWS have been responded to during the preparation of the revised HCP and this FEIS (see Appendices B and C).

4.13.6 <u>Magnuson-Stevens Fishery</u> Conservation and Management Act

Also known as the Magnuson Act, this act establishes a 200-mile fishery conservation zone and regional fishery management councils. The zone was amended to be the Exclusive Economic Zone, and its inner boundary includes the ocean shorelines of the coastal states, where Columbia River salmon and steelhead are found. The potential effects to fisheries in this zone include an overall increase in salmonid populations through an alternative's success in increasing salmonid survival through the three dams. The Magnuson Act was amended to give NMFS the jurisdiction of managing the habitat of commercially harvested fish.

4.13.7 CLEAN WATER ACT

The Clean Water Act of 1977 (33 USC 26) was designed to restore and protect the chemical, physical, and biological integrity of U.S. waters. The USEPA is responsible for enforcing the act, but has delegated enforcement authority to Ecology for waters within the State of Washington. The Colville Tribes have been delegated enforcement authority for water within the Colville Tribes Reservation. Sections 3.3 and 4.3, Water Resources (Quantity and Quality) discuss water quality issues related to the alternatives in this EIS and how the alternatives meet the regulations.

4.13.8 WETLANDS PROTECTION

Executive Order 11990 directs Federal agencies to minimize the destruction, loss, or degradation of wetlands. All waters of the U.S., including wetlands, fall under the Clean Water Act, and the U.S. Army Corps of Engineers is responsible for wetlands protection. Wetlands issues related to the alternatives are discussed in Section 4.4, Vegetation.

4.13.9 ENVIRONMENTAL JUSTICE

Executive Order No. 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations, requires that Federal agencies avoid unequal distributions of adverse effects to minority and low-income populations. Refer to Sections 3.12 and 4.12, Environmental Justice, for a more detailed description of how minorities and low-income populations were considered in this EIS.

4.13.10 STATE, AREA-WIDE, AND LOCAL PLAN AND PROGRAM CONSISTENCY

Executive Order No. 12372 instructs agencies to consider the consistency of a proposed action with approved State and local plans and laws. This EIS analysis discusses land use plans in Section 4.6, Land Ownership and Use; fisheries plans in Section 4.2, Fisheries Resources; recreation in Section 4.10. Recreation: and cultural resources in Section 4.11. Cultural Resources. However, given the size of the project area and the limited direct effects that were identified as a result of the proposed action, a detailed review of other land owners' plans, water rights agreements, and watershed plans was not determined to be applicable. To achieve the same goals, this EIS was prepared with input from cooperating and responsible agencies, and the EIS will be circulated with appropriate State and local entities to satisfy review and consultation requirements.

4.13.11 FLOODPLAIN MANAGEMENT

Executive Order 11988 requires Federal agencies to evaluate actions they might take in a floodplain and ensure that the actions consider flood hazards, floodplain management, and alternatives to avoid or minimize potential harm. Section 4.3, Water Resources (Quantity and Quality), of the EIS includes discussions of water quantity effects of the alternatives. However, the hydroelectric projects are run-of-the-river facilities not

designed for storage or flood control purposes, and the tributary actions would not involve plans to change the overall floodplain in the project area, except in the unlikely event of drawdown under Alternative 2. If drawdown is considered, a separate NEPA analysis would be conducted.

Tributary enhancement could involve changes in shoreline areas that would affect floodplains under all alternatives. Effects from flooding to land use are discussed in Section 4.6, Land Ownership and Use.

4.13.12 HERITAGE RESOURCE PROTECTION

A number of Federal laws protect the nation's historical, cultural, and prehistoric resources as described below.

4.13.12.1 National Historic Preservation Act

Section 106 of the National Historic Preservation Act requires that Federal agencies evaluate the effects of Federal actions on historical, archeological, and cultural resources and afford the Advisory Council on Historic Preservation an opportunity to comment on the proposed action. Compliance with the National Historic Preservation Act for all of the alternatives is discussed in Section 4.11, Cultural Resources.

4.13.12.2 Archeological Resources Protection Act and Native American Graves Protection and Repatriation Act

Section 4.11, Cultural Resources, of this FEIS discusses the potential for effects to resources protected by these acts, which protect the treatment of known and unknown archeological sites, Native American human remains, and cultural items. In the mainstem area of the project, all of the alternatives have the same potential for continued erosion, potential exposure, and damage of cultural sites in the

reservoir areas. Although the upstream tributary projects involve no known cultural or archeological resource sites, appropriate construction, monitoring, and surveillance programs would be necessary to prevent or minimize effects to resources as individual tributary projects are developed.

4.13.13 WATER RIGHTS

The western states obtained ownership of streams and control of the water within each State upon admission to the union. State laws regulate the acquisition and use of water and limit its use to beneficial purposes as defined by the State. Washington State law governs individual water rights, which are granted in terms of the type of water use, the period of use, the source of water, the location of the point of diversion and place of use, and the rate and total volume of water that may be diverted. Ecology is responsible for the State's water permitting program, and the mainstem Columbia River and each of the tributaries have highly complex water rights obligations. Although Alternative 3 proposes tributary enhancement programs in areas where existing water withdrawals have historically affected habitat, the HCPs would not involve major effects to existing water rights agreements. None of the alternatives would affect water rights on the mainstem Columbia River.

4.13.14 RECREATION RESOURCES

A number of acts require that Federal agencies consider and minimize the recreational and scenic effects of actions involving water resource projects. The primary acts affecting the Columbia basin are described below.

4.13.14.1 Wild and Scenic Rivers Act

The Wild and Scenic Rivers Act of 1968 designates qualifying free-flowing river segments as wild, scenic, or recreational. This act does not currently apply to rivers in the EIS study area.

However, designation for the Hanford Reach, a 50-mile free-flowing segment of the Columbia River below Priest Rapids Dam, has been considered repeatedly over the past several years, both in the U.S. Congress and in the Washington State Legislature. The Hanford Reach was declared a National Monument in 2000. Still, none of the alternatives would affect a potential designation because they would not have a significant adverse effect on water resources or fisheries in the reach. In addition, the plan area itself would not qualify for designation because of the existing reservoir impoundments.

4.13.14.2 Wilderness Act

The Wilderness Act of 1964 (16 USCA 1131) established the National Wilderness Preservation System. Areas designed under the act and subsequent legislation are to be administrated for the use and enjoyment of the public, leaving them unimpaired as wilderness. Development activities are generally prohibited, and Federal agencies must consider whether their actions would affect wilderness values. Although there are wilderness areas in the basin, none are located in the project area.

4.13.14.3 Water Resources Development Act

Congress authorizes and amends the Water Resources Development Act biennially. This act generally requires public and interagency participation in changes to reservoir operation criteria. The FERC licensing process (and the existing license conditions for the projects) ensures compliance with the act, and none of the alternatives considered in this EIS would involve substantial changes to reservoir operations, excepting the possibility of drawdown as described under Alternative 2. If drawdown is considered, it would be evaluated under a separate NEPA analysis in the future.

4.13.15 <u>FEDERAL WATER PROJECT</u> <u>RECREATION ACT</u>

This act (16 USCA 4612) requires full consideration of water resources projects for outdoor recreation and fish and wildlife enhancement. The FERC licensing process and the existing license requirements generally satisfy the requirements of the act. This EIS examines the additional fisheries requirements that may be needed for compliance with the Endangered Species Act.

4.13.16 POLLUTION CONTROL

Federal agencies are required to carry out other Federal environmental laws governing effects to people and the environment. However, the alternatives discussed in this EIS do not involve specific actions regarding pollution control laws, and instead consider broader decisions for Endangered Species Act compliance and resource protection. To the extent that subsequent projects (including tributary enhancement projects) would be implemented, appropriate documentation would be developed, and any applicable pollution control permits would be obtained.

4.13.17 <u>LEGISLATION PERTINENT TO TRIBAL</u> GOVERNMENTS

The United States Government's trust responsibility for Indian resources requires Federal agencies to take measures to protect and maintain treaty and trust resources. The responsibilities include legal interests and rights, including lands and resource use, such as Tribal rights to fisheries of Columbia Basin salmon and steelhead species. Hatchery fish also represent Indian treaty trust assets.

4.13.17.1 Secretarial Order 3206

This order, titled American Indian Tribes and the Endangered Species Act, was developed jointly by the Secretaries of Commerce and the Interior for NMFS and USFWS, and provides guidelines for coordinating Endangered Species Act compliance and Tribal trust responsibilities. The five principles of the 1997 Secretarial Order 3206 (American Indian Tribes and the Endangered Species Act) have been followed during HCP and EIS development for the three dams. These principles are: (1) working directly with the Indian Tribes on a government-to-government basis to promote healthy ecosystems, (2) recognizing that Indian lands are not subject to the same controls as Federal public lands, (3) assisting Tribes in developing and expanding Tribal programs so that healthy ecosystems are promoted and conservation restrictions are unnecessary, (4) being sensitive to Indian culture, and (5) making available to Tribes information related to Tribal trust resources and Indian lands and facilitating the mutual exchange of information and striving to protect sensitive Tribal information from disclosure.

The Colville, Umatilla, and Yakama Tribes hold rights to the affected fisheries. They have participated in the development of the HCP agreements, and they will be involved in implementation of the HCPs as members of the Coordinating Committee if they sign and become parties to the HCPs. For any Tribe that does not sign the HCPs, NMFS intends to coordinate directly with that Tribe regarding implementation of any HCP permit. NMFS has also provided additional opportunities for comments and coordination through the development of the original and revised HCPs and this EIS. Continued coordination and cooperation between the Tribes, NMFS, and the PUDs is planned under implementation of Alternatives 2 and 3.

The HCP agreements will supercede the 1989 Rock Island and 1990 Wells settlement agreements. The HCPs represent an increase in environmental protection over the pre-existing settlements. However, under the Wells and Rock Island settlement agreements, the Colville, Yakama, and Umatilla Tribes had the right to participate on the Mid-Columbia Coordinating

Committee. Without the HCP agreement (Alternatives 1 and 2), this right would have continued for each of those Tribes through the remaining term of the Wells and Rock Island licenses and any annual licenses issued prior to relicensing. Because the Umatilla and Yakama Tribes did not sign the HCPs, under Alternative 3, those tribes will not have the right to attend or vote at the Mid-Columbia committee meetings. The HCP agreements include provisions to allow any committees established under the agreement to allow the participation of any other governmental entity (including Tribes). Thus, the parties to the HCPs may elect to have the nonsignatory Tribes participate on the committees.

Tribal trust resources include both wild and hatchery fish, which would be affected differently by dam and by action alternative. Hatchery fish produced in the Mid-Columbia are subject to the treaty rights of the Yakama and Umatilla Tribes (U.S. vs. Washington, 759 F.2d 1353 [9th Cir. 1985]). Under Alternative 1, there would be no change in the amount of hatchery fish produced over time, although sockeye salmon production has been replaced with an option for the management of instream flows in the Okanogan River in Canada for the Wells Project, because the current hatchery production has not led to a substantial increase in adult runs.

Under Alternative 2, hatchery production would include the following:

• Wells Project - The same amount of chinook salmon and steelhead would be produced as described under Alternative 1, although production could be reduced because of the potential negative effects of hatchery fish on naturally spawning populations of Endangered Species Act-listed fish. In addition, Douglas County PUD would fund the changes in hatchery procedures and evaluations needed to make the hatchery compensation program consistent with the Endangered Species Act recovery goals for listed spring-run chinook salmon and steelhead populations. However, because of the potential effects of hatchery fish on natural populations, and considering that project-related mortality is 3.8 percent rather than the assumed 14 percent, hatchery production would be reduced under Alternative 2, particularly for the listed species.

• Rocky Reach and Rock Island projects - The same amount of chinook salmon and steelhead would initially be produced as described under existing conditions, although production could be reduced at any time because of the potential effects of hatchery fish on natural populations. Hatchery production of unlisted species would not be changed unless the production levels are determined to affect the listed species. In addition, changes in hatchery procedures and evaluations would be funded to ensure that the hatchery compensation program is consistent with recovery of spring-run chinook salmon and steelhead populations.

For Alternative 3, monitoring of both on-site and hatchery mitigation measures would be conducted, and mitigation measures would be modified as necessary to achieve or maintain the no net impact standard. Under Alternative 3, significant issues that concern the Tribes include whether NMFS can and should guarantee the HCPs' goal of no net impact. The goal includes a 7 percent hatchery production level to compensate for unavoidable project mortality. However, if NMFS determines at a future date that this level of hatchery production hinders propagation and survival of wild fish, it may be necessary to reduce the number of hatchery fish produced.

The HCPs allow NMFS to alter productions levels below 7 percent based on Endangered Species Act concerns at 2013 and every 10 years thereafter. Such a change in hatchery production would not negate the PUDs' obligation to meet a no net impact standard in 2013. The HCP

agreements include certain procedural safeguards to ensure that a decision to reduce hatchery production would be made only after thorough documentation and consideration of the need to do so. In addition, the HCPs ensure that any reduction in hatchery production will be accompanied by a commensurate increase in survival or other mitigation by requiring achievement of no net impact.

A comprehensive evaluation of the hatchery mitigation program would be conducted to assess the effectiveness for achieving the no net impact standard in 2013 and every 10 years thereafter. Based on the results of these evaluations, adjustments could be made to the program. However, hatchery compensation for unavoidable project mortality would not exceed 7 percent without agreement of the parties that signed the HCPs. Refer to Table 4-4 for the hatchery production estimate by project.

Tribal letters and comments on the DEIS are provided in Appendix B. Responses to Tribal letters on the DEIS and a description of NMFS's revisions to the HCPs in response to Tribal concerns are provided in Appendix C.

4.13.17.2 Federal Trust Responsibility

The Federal trust responsibility between Indian Tribes and the Federal Government is not defined, in part, because of reluctance by Tribes and Congress to place limits on "trust." Chief Justice Marshall characterized American Indian Tribes as "domestic dependent nations" involving (1) the government or nation-state status of Tribes, and (2) a special Tribal relationship with the United States (Cohen 1982). Marshall described the trust relationship as one that "resembles that of a ward to his guardian." This relationship has been consistently recognized by Federal courts ever since and has been described as "special," "unique," "moral," and "solemn." In addition, the rights reserved by the Tribes in treaties and agreements, which were not expressly terminated by Congress, continue to this day.

These Tribal rights and authorities extend to natural resources, which are reserved by treaties, executive orders, and Federal statutes. The Federal courts have developed the Canons of Construction, guiding premises, that treaties and other Federal actions "should when possible be read as protecting Indian rights in a manner favorable to Indians" (Cohen 1982).

The courts' interpretations of Tribal rights and treaty language continues to evolve and define Federal legal responsibilities. The primary focus of the Federal government trust responsibility is the protection of Indian-owned assets, natural resources on reservations, and the treaty rights and interests that Tribes reserved on offreservation lands. In carrying out its responsibilities, NMFS must assess proposed actions to determine potential effects on treaty rights, treaty resources, or other Tribal interests. Where potential effects exist, the agency must consult with affected Tribes and explicitly address those effects in planning documents and final decisions. Consultation with the Tribes is an essential step in carrying out that responsibility.

When used in the context of government-to-government relationships, the term consultation means an active, affirmative process that (a) identifies issues and seeks input from appropriate American Indian governments; and (b) considers their interests as a necessary and integral part of the NMFS decision-making process. The Federal government has a legal obligation to consult with American Indian Tribes. This legal obligation is based in laws, executive orders, and statutes. This legal responsibility is, through consultation, to consider Indian interests and account for those interests in the decision.

Formal consultation between NMFS and the Tribes on a government-to-government basis would occur prior to issuance of a ROD or a final biological opinion on the HCPs. The Services can withdraw from the HCP agreement and revoke the permit even if the no net impact standard has been met, if the Plan species are not

rebuilding and the projects are a significant factor in the failure to rebuild. The HCPs now specify that no net impact standards must be achieved by 2013. This allows adequate time to assess the project operation tools used to improve fish survival conditions and to evaluate these improvements over several fish population life cycles. These time periods include the 5 years (Phase I period beginning in 1999) for the PUDs to reach the performance standards, 3 years of evaluation of the juvenile survival metrics (juvenile project survival or juvenile dam passage survival), and about two adult return cycles.

The HCPs include a provision with respect to Indian Tribal treaty or reserved rights claims. The HCPs note that "nothing in this Agreement is intended to nor shall it in any way abridge, limit, diminish, abrogate, adjudicate, or resolve any Indian right reserved or protected in any treaty, executive order, statute or court decree." In addition, the HCPs have been revised to state that "this Agreement will not be utilized against another Party in any manner whatsoever in any legal proceeding other than a legal proceeding to enforce or interpret this agreement."

With respect to Tribal authorities in any other forum (e.g., U.S. vs. Oregon), there would be no difference between Alternatives 2 and 3.

4.13.18 TREATY OBLIGATIONS

4.13.18.1 Columbia River Treaty of 1961

This power planning treaty between the United States and Canada established four large reservoir dams in the Upper Columbia reaches, and defined the cooperative use of the dams for water supply, flood control, and power generation. Through the related agreement described below, the PUDs are responsible for providing a portion of the power benefits guaranteed to Canada by the treaty, and this treaty will not expire until 2024. No alternative will affect this treaty.

4.13.18.2 Pacific Salmon Treaty

In 1999, the United States and Canada signed an agreement for the long-term conservation and equitable sharing of their salmon resources. Most of the new fishery arrangements will be in effect for 10 years, beginning in 1999. The new agreement (1) established abundance-based fishing regimes for Pacific salmon fisheries under the jurisdiction of the Pacific Salmon Treaty; (2) created two bilaterally managed regional funds to promote cooperation, improve fishery management, and aid stock and habitat enhancement efforts; and (3) included provisions to enhance bilateral cooperation, improve the scientific basis for salmon management, and apply institutional changes to the Pacific Salmon Commission. The agreement's implementation will affect the quantity of fish available for commercial, recreational, and subsistence fisheries, as well as Indian treaty allocations. The goal of the Pacific Salmon Treaty is coordinated management of Pacific salmon throughout their range to ensure sustainable fisheries and maximize long-term benefits to the treaty parties. The 1999 agreement was reached within the framework of the Pacific Salmon Treaty Act of 1985 (Public Law 99-5, 99 Stat. 7: 16 U.S.C. 3631-3634) (Waldeck and Buck 1999).

The agreement established abundance-based fishing regimes for the Pacific salmon fisheries under the jurisdiction of the Pacific Salmon Treaty. These regimes, which allow fishery harvest to vary from year to year, are designed to implement the conservation and harvest-sharing principles of the Pacific Salmon Treaty. That is, larger catches will be allowed when salmon abundance is higher, and catches will be significantly constrained in years when stock abundance is down. It is believed that this type of regime will be more responsive to the conservation requirements of salmon than the fixed-catch ceilings that existed under the original Pacific Salmon Treaty arrangements (Waldeck and Buck 1999).

The cornerstone of the new fishing accord is abundance-based management. Under this management approach, harvest rates for each salmon stock are set relative to stock abundance. The objectives of abundance-based management are to (1) sustain wild stocks; (2) prevent overfishing; (3) set a predictable framework for sharing the burdens of conservation and benefits of stock recovery; (4) provide cost-effective, responsible fishery management; and (5) establish a common basis for stock assessment, fishery monitoring, and performance evaluation (Waldeck and Buck 1999).

Without Endangered Species Act protection, Alternative 1 would likely result in a decrease in wild stock available for harvest under the Pacific Salmon Treaty, thereby reducing the number of fish available for Indian harvest. With protection for listed salmon species and some additional protection for unlisted species, Alternative 2 should help improve salmonid stock available for harvest. Alternative 3 would result in greater short-term benefits for the Plan species as the PUDs reach their goals of no net impact. Over time, and once a biological opinion has been completed for all dams under Alternative 2, the benefits provided under either Alternative 2 or 3 should help increase salmonid populations available for harvest under the Pacific Salmon Treaty.

4.13.18.3 Wy-Kan-Ush-Mi Wa-Kish-Wit (Spirit of the Salmon)

The Spirit of the Salmon is an anadromous fish restoration plan for the Columbia River developed by the Columbia River Inter-Tribal Fish Commission, which represents the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes (CRITFC 1996). The plan's 25-year objectives are to rebuild salmon populations that will support Tribal ceremonial, subsistence, and commercial harvests and to rebuild lamprey and sturgeon populations to naturally sustainable levels. The plan includes hypotheses and

recommended actions, including subbasin-bysubbasin return goals and water restoration actions that could achieve the plan goals. Technical recommendations are to increase survival at each stage of the species' life cycle. Included in the plan are recommendations for hydroelectric operations, habitat protection and rehabilitation, fish production and hatchery reforms, and recommendations for in-river and ocean harvests. The Tribes are currently seeking to obtain support for the plan by local, State, Federal, and other Tribal governments. The action alternatives should help improve fish survival under the plan, and Alternative 3 will help support the Tribes' goal of habitat protection and rehabilitation. Alternative 1 will not support this plan because no increased salmonid survival would occur.

4.14 UNAVOIDABLE ADVERSE EFFECTS

Any of the alternatives considered in this FEIS could result in adverse environmental effects, including those that cannot be avoided or completely mitigated. For each resource area that may be affected, Chapter 4 describes the anticipated effects and describes measures that can be taken to avoid or mitigate the effects and to lessen the significance of the effects.

Again, it is important to distinguish the ongoing and historic adverse effects of the hydroelectric projects from the probable effects of the alternatives. All of the alternatives involve approaches to minimize harm to fish species, to compensate for fish losses, and to enhance the potential for species survival.

All alternatives would result in mortality to Federally protected salmon and steelhead. Alternative 3 proposes mitigation and enhancements to result in no net impact, the equivalent of 100 percent survival for all Plan species.

In large part, specific details about individual actions that would occur under Alternatives 2 and 3 are still to be determined, based on additional technical studies. However, Alternatives 2 and 3 involve a long-term monitoring program designed to document the level of effects and to allow the PUDs to respond with necessary actions to minimize or mitigate for potential effects.

4.15 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

None of the alternatives involve an irreversible commitment to use, modify, or affect non-renewable resources such as cultural resources or minerals. However, the alternatives do involve protected salmon and steelhead species, which historically have been considered a renewable resource but are now in threat of extinction. As salmon and steelhead recovery may occur over a long but still unknown period of time, the 50-year term of Alternative 3 does involve a commitment of resources to protect salmon and steelhead. Incidental take of the protected species would be allowed as long as the HCPs are implemented as agreed.

Under Alternative 2, an irretrievable commitment could occur if the species continue to deteriorate to the point that renewal can only occur over a longer period of time and at great expense. However, the analyses conducted for this EIS did not reveal that Alternatives 2 and 3, designed to protect endangered or threatened fish, involved substantial differences in their effect on the protected species. Alternative 1 can only protect endangered and threatened fish through ongoing license agreements. None of the other activities related to the HCPs or the proposed action is considered likely to result in an irreversible and irretrievable commitment of resources.

4.16 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

This discussion considers some of the differences between short-term needs and uses of the environment and resources and maintaining and enhancing long-term productivity. In most resource areas, the two action alternatives would not have substantially different results. Alternative 1 would result in the highest likelihood of extinction for listed species, and therefore, it is not a viable long-term alternative. Based on existing information, Alternatives 2 and 3 appear to have a similar potential to increase listed salmon and steelhead populations, support increased productivity, and potentially contribute to the long-term recovery of the protected species, although Alternative 3 would likely be implemented more rapidly than Alternative 2 (see Section 2.6.5, Implementation Schedule). Although similar improvements and enhancements to the projects are proposed for the action alternatives, only the HCPs (Alternative 3) include a program for enhancing tributaries and substantially increasing the survival and productivity of unlisted anadromous fish.

The primary consideration would be between the competing short-term and long-term needs for ensuring salmon and steelhead survival and recovery and providing power. The PUD proposed action, Alternative 3, is for a 50-year permit to operate the projects under the HCPs, allowing the PUDs to take a long-term approach for complying with the Endangered Species Act and to plan and market their power production programs. This would improve the PUDs' abilities to obtain long-term financing, develop long-term power sales agreements, and maintain the low utility rates they now provide to their customers. At the same time, the HCPs define the level of mitigation and compensation that would be required over the 50-year period in terms of funding the HCPs and modifying operations at the plant.

While individual actions can be modified as needed, the level of funding for hatchery and tributary compensations and the performance goals cannot be changed as long as the HCPs are being implemented as agreed. While this provides a substantial amount of planning and financial certainty for the PUDs and their customers, there is some risk of uncertainty on the long-term effects to the species, given the limits of existing information. Alternatives 2 and 3 incorporate an adaptive management approach designed to reduce this risk of uncertainty by allowing the PUDs, the resource agencies, and others to adjust their programs based on new information. There are also options for resource agencies to withdraw from the HCP if this program is not meeting the needs of the listed species.

Alternative 2, however, could require modifications to the project features as necessary to aid in the recovery of listed species at any time as long as the species remain Federally protected. Additional protection for unlisted species could occur at project relicensing periods. Alternative 2 does not provide a maximum amount of funding or operational changes that could ultimately be required. At any time, new information about protected species in the Mid-Columbia River Basin could reopen discussions about the effects of the projects and the actions that may be required. This would provide the maximum amount of flexibility for managing overall recovery of listed Upper Columbia River species (although delays in implementation of new protective measures would be likely as a result of FERC's administrative processes and litigation), but it provides a substantially lower level of planning and operating certainty for the PUDs. While it is impossible to predict the full range of actions that could be required in the future, they most likely would involve increased funding from the PUDs for species recovery and changes in

hydropower operations, some of which could substantially reduce power production capabilities.

Alternative 1 mitigates for some of the effects caused by project operations through existing license stipulations, amendments, and settlement agreements. Alternative 2 provides additional protection for species once they are listed as threatened or endangered, and for unlisted salmonid species during license reopener and relicensing occurrences, although the extent of protection is unknown and the timeline for implementation is uncertain for unlisted species. Alternative 3 is designed to provide no net impact survival conditions for both Endangered Species Act-listed and unlisted anadromous salmonids in the middle reach of the Columbia River. The HCPs would reduce the likelihood of extinction and enhance recovery opportunities for listed fish. The HCPs would help to rebuild and protect unlisted anadromous salmonid populations with the goal of preventing their future listing under the Endangered Species Act.

Alternative 3 would also provide long-term habitat improvements to the tributaries over the next 50 years through annual funding to the Plan Species Account. The funds would be used by the Tributary Committee to restore and enhance salmonid breeding habitat.



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CHANGES MADE BETWEEN THE DEIS AND FEIS FOR CHAPTER 5

- Chapter 5 is a cumulative effects analysis that was previously placed in Chapter 4 by resource section under the subsection titled Columbia River System. Due to the public request to expand and relocate the cumulative effects analysis to a separate chapter for ease in locating the analysis, these sections are now consolidated under Chapter 5.
- Included in Chapter 5 is a cumulative effects analysis by Evolutionarily Significant Unit.
- Cumulative effects sections were added for those resources not previously included in the DEIS, including Aesthetics and Environmental Justice.

5 CUMULATIVE EFFECTS

5.1 Introduction

Cumulative effects, also called cumulative impacts, are those environmental consequences that result from the incremental effects of an activity when added to other past, present, and reasonably foreseeable future actions, regardless of which agency, person, or other entity undertakes them (see CFR 1508.7). For this EIS, potential cumulative effects include activities described within the Columbia River system that may affect the natural resources within the project area, especially Plan species.

The identification and analysis of cumulative effects provides regional decision-makers and the public the context within which the effects are occurring and the environmental implications of the interactions of known and expected management activities. The Columbia River system is an ecologically complicated and intensively managed system that requires sophisticated analyses of potential cumulative effects from proposed project activities. However, during subsequent analyses of site-specific activities, local cumulative effects would be assessed in greater detail on a project basis.

The alternatives analyzed in this EIS would establish management direction that allows for the use of mitigation measures (referred to as tools in the HCP) for increasing salmonid survival within the Wells, Rocky Reach, and Rock Island Dam project areas. A consistent management direction within the project area would provide a coordinated aquatic management structure for addressing the biological needs of anadromous salmonid species in the Mid-Columbia River region.

This cumulative effects section describes the incremental and interactive effects that the three Mid-Columbia PUD dams may have on other recovery activities within the Columbia River ecosystem. The cumulative effects analysis in this chapter analyzes how those activities that are planned or expected to occur in the river system would affect or be affected by the activities resulting from the implementation of the action alternatives. The cumulative effects analysis is on a resource-by-resource basis, with special emphasis on aquatic systems.

Federal, State, Tribal, and local government actions are likely to be in the form of legislation, administrative rules, or policy initiatives that may include changes in land and water use patterns. These potential changes could affect anadromous fish species or their habitat. In addition, the geographic scope of the affected area, which encompasses numerous government and private entities exercising various authorities or rights, make any analysis of cumulative effects difficult and even speculative. This section identifies management actions that, based on currently available information, are reasonably certain to occur. It also identifies goals, objectives, and proposed plans by State and Tribal governments.

Actions of Federal, State, Tribal, and local entities, as well as private landowners, are expected to continue affecting listed and unlisted species in the Columbia River basin. The cumulative effects are difficult to accurately analyze considering the broad geographic landscape, the socioeconomic and political variation in the area, and the uncertainties associated with government and private actions.

5.2 EVOLUTIONARILY SIGNIFICANT UNITS

Two Evolutionarily Significant Units, listed as endangered under the Endangered Species Act, occur in the Mid-Columbia River region.

Although these populations are affected by the operations of the Mid-Columbia River PUD dams, they are also affected by activities in the tributary areas, as well as activities in the Lower Columbia River. Many of these independent activities would be similar for all the alternatives.

5.2.1 <u>UPPER COLUMBIA RIVER SPRING-RUN</u> <u>CHINOOK SALMON</u>

The Upper Columbia River Evolutionarily Significant Unit of spring-run chinook salmon was listed as endangered under the Endangered Species Act in March 1999 (NMFS 1999a). Spring-run chinook salmon are found in all of the major watersheds in the Mid-Columbia River except the Okanogan River drainage. Three independent populations of spring-run chinook salmon are identified for the Evolutionarily Significant Unit, including those that spawn in the Wenatchee, Entiat, and Methow Basins (Ford et al. 1999).

The extinction risks for these populations are 50 percent for the Methow, 98 percent for the Wenatchee, and 99 percent for the Entiat River populations. These extinction risks represent existing conditions under Alternative 1, and are based on the assumption that the median adult returns from the 1980 through 1994 brood years will continue into the future.

5.2.2 UPPER COLUMBIA RIVER STEELHEAD

The Upper Columbia River Evolutionarily Significant Unit of steelhead was listed as endangered under the Endangered Species Act in August 1997 (NMFS 1997). NMFS considers all steelhead returning to tributary streams upstream of the confluence of the Yakima River as belonging to the same Evolutionarily Significant

Unit (61 Federal Register, 960730210-6210-01). This Evolutionarily Significant Unit includes steelhead spawning in the Wenatchee, Entiat, Methow, and Okanogan watersheds, and smaller tributaries to the Mid-Columbia River. However, due to limited data, these populations are evaluated as two aggregate spawning groups — Wenatchee/Entiat composite and the Methow composite.

Only anadromous forms of steelhead are listed due to uncertainties regarding the status of resident forms (rainbow trout), and interactions between the two life-history forms. The steelhead produced at the Wells Fish Hatchery are included in the Evolutionarily Significant Unit because NMFS considers them essential to the recovery of natural populations.

The extinction risks for these populations vary as a result of assumptions relative to the effectiveness of hatchery fish to spawn naturally. At the low end, assuming that hatchery fish reproduce about 25 percent as effectively as wild fish, the risk of extinction is about 28 percent for the Methow composite and 35 percent for the Wenatchee/Entiat composite. However, assuming that hatchery fish reproduce as effectively as wild-origin fish, the extinction risk increases to 100 percent for both groups.

5.3 FEDERAL PROGRAMS DEVELOPED FOR SALMONID RECOVERY

A number of Federal programs have been initiated in recent years to increase the overall abundance of salmon and steelhead in the Columbia River Basin. These programs were developed to address concerns for all the anadromous salmonid species, though particular emphasis is placed on the Endangered Species Act-listed stocks.

The following reports collectively outline the current Federal initiatives for salmon recovery in the basin for the years 2001 through 2010.

- 2000 Columbia River Basin Fish and Wildlife Program – Northwest Power Planning Council (2000)
- Final 2000 Federal Columbia River Power System Biological Opinion – NMFS (2000a)
- *Cumulative Risk Initiative* NMFS (2001b)
- Conservation of Columbia Basin Fish: Final Basinwide Recovery Strategy or All-H Paper
 Federal Caucus (2000)
- Interior Columbia Basin Final Environmental Impact Statement and Proposed Decision – USFS and BLM (2000)
- Biological Opinion on Federal Columbia River Power System Operations Affecting Bull Trout and Kootenai River White Sturgeon – USFWS (2000)

These documents address proposed recovery processes for listed species, as well as overall improvements in the environmental conditions throughout the basin for the benefit of all aquatic species. The reports focus on four general areas of concern in the recovery process: mainstem habitat and passage, tributary habitat, harvest, and hatcheries.

5.3.1 Mainstem Habitat and Passage

The documents described above represent a substantial effort to address mainstem habitat and passage problems. The 2000 Columbia River Basin Fish and Wildlife Program outlines the principles, goals, and general strategies for recovery. The Basin-wide Recovery Strategy, the Cumulative Risk Initiative, and the biological opinions provide further details of programs that are oriented to address listed species' life cycles. The strategies include reform of hatchery and habitat restoration practices throughout the basin from the estuary to the tributary areas. The strategies also include reforming harvest management and operational methods, together with improved funding and accountability, for improvements to ecosystem health and fish protection. The primary objective of these actions is to provide benefits to juvenile and adult salmon passage through the hydroelectric system, thus providing cumulative benefits to the proposed action alternatives.

5.3.2 Tributary Habitat

The 2000 Columbia River Basin Fish and Wildlife Program outlines conceptual and procedural approaches to tributary habitat restoration, while the biological opinions and Basin-wide Recovery Strategy contain more substantive discussions of tributary habitat. The process for recovering tributary habitat to improve adult spawning and juvenile rearing conditions would result in the production of more fish that would benefit from beneficial actions provided by the HCPs. Restoration of degraded tributary habitat is one objective of the 2000 Columbia River Basin Fish and Wildlife Program.

5.3.3 HARVEST

The documents do not directly address harvest but assume that the recent trends in harvest management will continue. These trends include substantial reductions in the total exploitation rates on naturally spawning salmonid populations, fishing regimes responsive to changes in abundance, and management of total fishing mortality (i.e., catch plus associated incidental mortality). The documents support the expansion of selective fishing techniques and the development of mass-mark selective fisheries. The implicit assumption in mass-marking programs is that the programs will enhance selective harvest of hatchery fish and conservation of wild spawned fish.

5.3.4 HATCHERIES

Hatchery reform measures that have been implemented or proposed are discussed in the documents described above. The documents also discuss supplementation and captive rearing programs that are included in the plans.

5.3.5 CURRENT STATUS FEDERAL PROGRAM

NMFS recently issued a progress report on the 199 actions to be implemented within the Federal hydrosystem of the Columbia River Basin (NMFS 2002b). Their review of available information produced the conclusion that implementation of the Basin-wide Salmon Recovery Strategy is generally consistent with the 2000 Federal Columbia River Power System biological opinion, and is adequate to implement the reasonable and prudent alternative for the 199 actions. Of the 124 actions that require definition, implementation, or completion by 2003, 94 are being implemented as expected; the 30 remaining actions are being implemented during 2002. The 75 actions scheduled for later implementation will be implemented by 2010, with 66 of these implemented by 2003. Thus, the beneficial effects of the 199 actions included in the 2000 biological opinion will provide a cumulative benefit, in addition to the HCP provisions.

5.4 REGIONAL PROGRAMS DEVELOPED FOR SALMONID RECOVERY

Although the primary emphasis of the Federal programs to recover Columbia River salmon and steelhead populations is improving juvenile and adult fish passage conditions in the mainstem, regional programs tend to emphasize tributary habitat. One regional emphasis is to ensure adequate instream flows for fish through acquisition of water rights. Restrictions or moratoriums have minimized the number of new water right applications approved within the Columbia River Basin in recent years. Although there is strong support by some interests to ease or eliminate restrictions on water use and development, there are also Ecology and Bureau of Reclamation initiatives to buy-back or lease water rights for increasing instream flows in the various watersheds.

The Northwest Governors released their Recommendation for the Protection and Restoration of Fish in the Columbia River Basin in July 2000 (Kempthorne et al. 2000). The goal was the "protection and restoration of salmonids and other aquatic species to sustainable and harvestable levels meeting the requirements of the Endangered Species Act, the Clean Water Act, the Northwest Power Act, and Tribal rights under treaties and executive orders while taking into account the need to preserve a sound economy in the Pacific Northwest." The report includes recommendations for habitat, harvest, and hatchery reforms. The implementation of these recommendations should benefit anadromous fish species and their habitat throughout the basin.

Habitat improvement recommendations include:

- designating priority watersheds and developing watershed management plans;
- coordinating Federal, State, and local planning processes with the Northwest Power Planning Council's Fish and Wildlife Program; and
- working with Federal, State, Tribal, and local governments to implement the National Estuary Program for the Lower Columbia River estuary.

Harvest initiatives include:

- evaluating selective harvest methods and regulations;
- evaluating license buyback programs;
- establishing terminal fisheries below Bonneville Dam and in Zone 6;

- strengthening Federal, State, and local law enforcement programs; and
- increasing predator control fishery programs to minimize the loss of salmonids from predation.

Hatchery reform initiatives include:

- implementing recommendations in the Artificial Production Review Report (Northwest Power Planning Council 1999);
- supporting the regional fish managers and Tribes to develop a comprehensive supplementation plan, including monitoring and evaluation; and
- developing more comprehensive hatchery fish marking programs.

5.5 STATE PROGRAMS DEVELOPED FOR SALMONID RECOVERY

In addition to the overall recommendations of the Northwest Governors, each State has independent initiatives that are expected to affect anadromous fish or their habitat in the basin.

5.5.1 OREGON

Proposed actions by the State of Oregon are described in the *Oregon Plan for Salmon and Watershed Measures* (Oregon Plan 2001), which includes the following programs:

- water quality management plans Oregon Department of Agriculture;
- TMDLs in targeted basins Oregon Department of Environmental Quality;

- watershed enhancement programs and land and water acquisitions – Oregon Watershed Enhancement Board;
- instream flow enhancement programs –
 Oregon Department of Fish and Wildlife and
 Oregon Water Resources Department;
- fish passage and culvert improvements and replacements – Oregon Department of Fish and Wildlife and Oregon Department of Transportation;
- improvements in forest habitat and other State-owned lands – Oregon Department of Forestry, Oregon Division of State Lands and Oregon Parks Department;

- reductions in sediment runoff from mine sites
 Department of Geology and Mineral Industries; and
- State agencies funding local and private habitat initiatives and providing technical assistance for establishing riparian corridors.

Following the development of the Oregon Plan (2001), Oregon voters approved a broad constitutional amendment requiring payment to private property owners for diminution in property values resulting from State and local regulations. This amendment may limit the development of the above-mentioned regulatory initiatives.

5.5.2 Washington

Several legislative measures have been passed in the State of Washington to facilitate the recovery of listed species and their habitats, as well as the overall health of watersheds and ecosystems. The 1998 Salmon Recovery Planning Act provides the basis for developing watershed restoration projects and establishes a funding mechanism for local habitat restoration projects. The Act also created the Governor's Salmon Recovery Office to coordinate and assist in the development of salmon recovery plans.

The Statewide Strategy to Recover Salmon is also designed to improve watersheds, while the 1998 Watershed Planning Act encourages voluntary water resource planning by local governments, citizens, and Tribes in regards to water supply, water use, water quality, and habitat at the WRIA level. The Salmon Recovery Funding Act established a board to approve localized salmon recovery funding activities.

WDFW and Tribal co-managers implemented the Wild Stock Recovery Initiative in 1992 and completed comprehensive management plans that identify limiting factors and habitat restoration activities. These plans also include actions in the harvest and hatchery components.

Although the Washington legislature amended the Shoreline Management Act to increase protection of shoreline fish habitat, a recent court challenge will delay implementation and possibly require additional amendments. Washington State's Forest and Fish Policy is designed to establish criteria for non-Federal and private forest activities that will improve environmental conditions for listed species, primarily to minimize impacts to fish habitat through protection of riparian zones and instream flows.

The State of Washington is under a court order to develop TMDL management plans on each of its 303(d) water-quality-listed streams, which will result in water quality improvements. The State also established an ongoing program in 2000 to buy or lease water rights for instream flow purposes. The mainstem Columbia River was closed by the State to new water rights appropriations in 1995. These programs should improve water quantity and quality in the State over the long term.

In addition to the programs and initiatives identified for Oregon and Washington, similar programs have been or are being developed in Idaho and Montana. Although these programs would have a greater affect on the Snake River fish populations, they are likely to benefit the Mid-Columbia River stocks as they migrate through the Lower Columbia River.

5.6 INDIAN TRIBES

The Nez Perce, Umatilla, Warm Springs, and Yakama Tribes have developed a joint restoration plan for anadromous fish in the Columbia River basin, known as the *Wy-Kan-Ush-Mi Wa-Kish-Wit*, or *Spirit of the Salmon* plan (CRITFC 2002). The plan emphasizes the reliance on natural

production and healthy river ecosystems, and addresses hydroelectric operations on the mainstem Columbia and Snake Rivers; habitat protection and restoration throughout the basin (including the Columbia River estuary); fish production and hatchery reforms; and in-river and ocean harvest reforms. The plan provides a framework for restoring anadromous or migratory fish stocks (specifically salmon, steelhead, Pacific lamprey, and white sturgeon) in areas upstream of Bonneville Dam.

The plan should have positive cumulative effects on anadromous and migratory species and their habitat, and includes the objectives of:

- halting the decline of salmon, lamprey, and sturgeon populations in areas upstream of Bonneville Dam within 7 years;
- rebuilding salmon populations upstream of Bonneville Dam to annual run sizes of 4 million fish within 25 years in a manner that supports Tribal ceremonial, subsistence, and commercial harvests; and
- increasing lamprey and sturgeon populations to naturally sustaining levels within 25 years in a manner that supports Tribal harvests.

5.7 RESOURCE EFFECTS

5.7.1 LAND FEATURES, GEOLOGY, AND SOILS

Through review of Federal, State, regional, and Tribal plans, there are no known geologic or soil-based activities that are expected to occur within the Columbia River system that would either affect or be affected by the proposed activities associated with any of the EIS alternatives. Ongoing or future modifications of project facilities, hatcheries, and spill operations are not expected to alter Columbia River soils and sediment conditions outside the immediate project area. Planned or future modifications of other Columbia River Basin hydroelectric projects, including the possible removal of some Snake River dams, would not alter geomorphic conditions in the Mid-Columbia River region.

Tributary restoration projects would not appreciably affect Columbia River sediment conditions. The potential for increased stream turbidity from instream restoration activities would be minimized and diluted prior to reaching the Columbia River through the use of Federal, State, and local land management permit requirements. These permits require best management practices and temporary erosion and sediment control plans for those land-based

activities that could affect adjacent waters. Included in these permits is the hydraulic permit approval issued by WDFW, which is required for any form of work that uses, diverts, obstructs, or changes the natural flow or bed of any freshwater of the State. Tributary restoration projects would likely result in decreased watershed and riverbank erosion and reduced sediment delivery to the Columbia River over the long term. Columbia River sediment, baseline, or soil conditions are not expected to be altered. Stable reservoir levels under the action alternatives would also maintain current shoreline and sedimentation conditions in the reservoirs.

5.7.2 <u>FISHERIES RESOURCES</u>

The cumulative effects associated with operating the Mid-Columbia River hydroelectric projects on spring-run chinook salmon and steelhead, and the projected changes in fish population numbers, as a result of implementing the survival standards and tributary improvements of the HCPs, were assessed in the Mid-Columbia River Quantitative Analysis Report (QAR). A summary of this report can be found in Appendix E. The inclusion of summer/fall-run chinook, sockeye, and coho salmon as Plan species under Alternative 3

affords these unlisted species the same level of protection provided to the Endangered Species Act-listed species. Although the QAR analysis focuses on survival changes relative to the HCPs (Alternative 3), Section 7 consultations conducted under Alternative 2 are expected to result in benefits for the listed species, and potentially indirect benefits to some unlisted species. Alternative 1 continues existing conditions, resulting in no new protection programs for either the listed or the unlisted species.

5.7.2.1 Endangered Anadromous Salmonid Species

The QAR represents a long-term cumulative effects analysis for endangered Upper Columbia River spring-run chinook salmon and steelhead. The analysis includes the following components:

- summarizes the available information for the Endangered Species Act-listed anadromous species;
- reviews alternative approaches to estimating the risks of extinction and recovery perspectives; and
- provides preliminary estimates of the relative risks of extinction under a range of alternative management, climate, and environmental scenarios.

The QAR also provides analyses of the potential survival improvements that could be gained throughout the life cycle of listed Upper Columbia River salmonids from hydropower system modifications, enhanced habitat, and changing climate and environmental conditions (e.g., ocean survival).

Within the spring-run chinook salmon and steelhead Evolutionarily Significant Units identified in the Upper Columbia River, there are three independent populations (one each on the Wenatchee, Entiat, and Methow Rivers). These independent populations represent aggregations

of one or more local breeding units (demes) that are closely linked by the exchange of individuals among the demes, but are isolated from other independent populations. The QAR analyses are intended to determine the following information for the three independent populations of the listed species:

- Extinction Risks Assess the potential risks of extinction for the major wild populations of the Upper Columbia River steelhead and spring-run chinook salmon Evolutionarily Significant Units given a continuation of recent management and environmental conditions associated with adult returns.
- Extinction Risk Reductions Assess how the projected extinction risks would be affected by proportional increases in the average return per spawner ratios (i.e., the number of returning adult spawners divided by the total number of parent spawners for each brood year (year of spawning).
- HCP Effects Specifically assess how the extinction risks and recovery probabilities might be affected by the implementation of passage survival improvements and the tributary enhancement programs identified in the three HCPs.
- Combined Effects Determine the projected combined effect of the passage survival and tributary improvements identified in the HCPs and the potential additional mitigation measures expected from Federal actions that involve hydropower and habitat (tributary and estuarine). However, artificial supplementation (hatchery production) and harvest modifications were not analyzed.
- Other Effects Determine if additional survival improvements would be needed to achieve survival and recovery objectives for these runs.

For Upper Columbia River spring-run chinook salmon populations, the available data set begins in the late 1950s and early 1960s. To be consistent with other cumulative effects models (e.g., Cumulative Risk Initiative), NMFS applied the most conservative data set available to assess extinction risk and probability of achieving the interim recovery goals. The most conservative data set reflects conditions for brood years 1980 through 1994, although for comparative purposes, the full data set (1960 through 1994 brood years) was also analyzed and reported.

Status of Modeled Populations

The extinction risks for wild Upper Columbia River spring-run chinook salmon and steelhead were assessed by estimating the total annual run sizes and determining the resultant return per spawner ratios. To determine annual run sizes, estimates of pre-spawning mortality, captured broodstock, and harvest rates were added to the annual escapement numbers recorded during spawning ground surveys. The total component of hatchery fish could then be determined and factored out of the spawning populations to estimate total adult returns from wild, naturally spawning parents. The annual returns were then separated into age classes to determine the contribution from each brood year. The annual returns from each brood year were summed to estimate the total number of adults that returned from wild, naturally spawning parents each year (i.e., the return per spawner ratio).

A stable population requires an excess of one returning adult for every adult spawner to account for harvest rates and instream adult mortality. At spawning, a stable population requires a minimum of one return spawner for each spawning parent (i.e., a return per spawner ratio of 1.0). If this ratio is less than one, the population decreases and the risk of extinction increases.

Return per spawner ratios are a common way of expressing the productivity of salmon stocks.

They reflect the average rate of replacement over the life of a generation—typically 4 to 5 years for chinook salmon. Return rates can also be expressed as annual growth rates (often termed lambda). The QAR modeled the recent (1970 through 1994 and 1980 through 1994 brood years) return per spawner ratios to generate projections of temporal trends or patterns in spawning escapement that can be compared to specific extinction risk criteria over time for spring chinook. In recent years (1980 through 1994 brood years), return rates for Upper Columbia River spring-run chinook salmon translate into annual return rates of 0.89 to 0.98. These results indicate the populations have been trending down at a loss rate of 2 to 11 percent per year.

Estimating the return per spawner ratio for wild steelhead was complicated by the relatively high proportion of hatchery steelhead that spawn naturally. Between 1976 and 1992, the average percent of the spawning populations comprised of wild origin adults was estimated at 27.9 and 11.2 percent in the Wenatchee/Entiat and the Methow Rivers, respectively.

Given the ultimate focus of Endangered Species Act objectives on naturally self-sustaining populations of wild fish, the steelhead productivity analyses in the QAR centered on a special case—scenarios in which hatchery inputs into natural spawning areas would immediately cease. The extinction risks and recovery analyses reported in the QAR all reflect this hypothetical assumption, even though this is unlikely to occur under either Alternative 2 or 3. There would be no changes to the hatchery programs under Alternative 1, which represents existing conditions.

To estimate return per spawner ratios for wild steelhead, an assumption must be made concerning the spawning effectiveness of hatchery fish. Assuming a 100 percent spawner effectiveness level for straying hatchery fish, the average return per spawner ratios for wild steelhead between 1976 and 1996 on the Wenatchee/Entiat and Methow Rivers were 0.41 and 0.28, respectively. However, with the assumption that hatchery fish were only 50 percent effective at spawning naturally, the return per spawner ratios for wild steelhead increased to 0.66 and 0.45. Assuming that hatchery spawners were only 25 percent effective at spawning further increased the return per spawner ratios for wild steelhead to 0.70 and 0.65.

Extinction Risk Criteria

Three population level criteria were considered in the QAR:

- Absolute Extinction Level Defined as one or fewer wild spawners in 5 or more consecutive years.
- Quasi-Extinction Level Defined as 50 or fewer wild spawners (Methow and Wenatchee Rivers) or 30 or fewer wild spawners (Entiat River) for 5 or more consecutive years. This is the abundance level at which a population is believed to be at extremely high risk of extinction in the immediate future and results in risks that are not usually incorporated into simple population extinction models.
- Cautionary Level Defined as 1,200 or fewer wild spawners per year for the Wenatchee River, 750 for the Methow River, and 150 for the Entiat River.

Interim population recovery goals for spring-run chinook salmon populations were set in the QAR at 3,750 spawners per year in the Wenatchee River, 2,000 spawners per year in the Methow River, and 500 spawners per year for the Entiat River. Interim recovery goals for the three steelhead populations were set at 2,500 spawners for the Wenatchee and Methow Rivers and 500 spawners for the Entiat River.

Factors Affecting the Extinction Risks

Major resource management factors affecting the extinction risks of the Upper Columbia River spring-run chinook salmon and steelhead include:

- harvest,
- hatchery production,
- habitat quantity and quality, and
- hydropower.

These factors are directly influenced by resource management practices and can be altered to increase the survival of listed species.

An additional factor, which is independent of management practices, is the fluctuation in climate and environmental conditions. This fluctuation is believed to have a substantial effect on the ocean survival of anadromous fish species, although the process is not well understood. A key objective of the QAR analyses is to depict the relative improvement in survival necessary to achieve extinction risk and recovery objectives under different assumptions about future climate and environmental survival scenarios. However, the results of analyses using data that represent the poorest climate and environmental conditions (worst-case scenario) are presented in this assessment, providing the most conservative comparison level.

Harvest

Harvest impacts on Upper Columbia River spring-run chinook salmon and steelhead are dominated by in-river fisheries. Until the early 1970s, Upper Columbia River spring-run chinook salmon were harvested, along with returning Snake River stocks in the Lower Columbia River commercial and sports fisheries (WDFW 1999). Harvest rates in those fisheries ranged between 30 and 50 percent per year. However, these fisheries were curtailed substantially in the early 1970s in response to declines in returns and recognition of treaty harvest needs. In recent years, harvest rates

have been reduced further due to listings under the Endangered Species Act.

Steelhead harvest rates in lower river commercial fisheries were relatively high through the 1960s. Direct commercial harvest of steelhead in non-Indian fisheries was eliminated by legislation in the early 1970s. Incidental impacts to steelhead through fisheries directed at other species continued in the lower river, but at substantially reduced levels. In the late 1970s and early 1980s, recreational fishery impacts to steelhead in the Upper Columbia River escalated to very high levels in response to increasing returns augmented by substantial increases in hatchery production and harvest reductions in the Lower Columbia River. Harvest rates on wild steelhead between 1975 and 1985 averaged 10 percent in the Lower Columbia River and 50 to 75 percent above Wells Dam. In 1985, recreational steelhead fishing regulations in this region (and in other Washington tributaries) were changed to mandate the release of wild fish. Treaty harvest of summer-run steelhead (including returns to the Upper Columbia River) occurs mainly in mainstem fisheries directed at up-river bright fallrun chinook salmon.

The basic analyses conducted in the QAR assume that current average harvest rates (encompassing incidental sport and commercial catches) would continue into the future. Those harvest rates generally reflect recent reductions imposed in response to stock listings and general downturns in abundance.

Harvest levels are expected to be relatively similar for all the EIS alternatives, although harvest levels might continue to be limited by the proportion of hatchery and naturally spawning fish. Although relatively large returns of hatchery fish have occurred in the Columbia River in recent years, harvest has typically been restricted because of potential impacts from the incidental catch of the relatively low numbers of natural spawning fish. Similar restrictions are expected to continue under Alternative 1.

Under Alternative 2, NMFS is likely to require a decrease in hatchery production levels, to reduce the potential affects of hatchery fish on the Endangered Species Act-listed species, and to increase the recovery potential (see Section 3.2.4.4, Interaction Between Hatchery Stocks and Wild Stocks). Although similar reductions could also occur under Alternative 3, such reductions would not occur until at least 2013. The hatchery production levels compensating for juvenile fish passage losses at Wells Dam are also expected to decrease, under all the alternatives, because the survival rates are greater than those originally estimated for the 1990 Wells Settlement Agreement (FERC 1990). Decreased hatchery production is likely to reduce the number of harvestable fish in the short term, but increased harvest is expected in the long term as natural stocks recover.

Hatchery Production

Each of the Upper Columbia River tributaries has an associated set of hatchery production programs. Hatchery production, especially of steelhead, increased dramatically in the 1960s and 1970s. Steelhead runs have been predominantly of hatchery origin since at least the early 1970s. Adults returning from these programs can stray and contribute to the production of natural spawning areas. However, the effectiveness of hatchery fish spawning naturally is unknown. The uncertainty related to the historical effectiveness of hatchery fish spawning in the wild has a significant effect on estimates of the wild population productivity.

State hatcheries funded by the Mid-Columbia River PUDs were established to mitigate for the effects of initial inundation of the hydroelectric projects on anadromous fish habitat. These facilities also provide mitigation for ongoing fish passage losses of anadromous fish at the projects. These hatchery programs are covered under a separate Endangered Species Act consultation process, and will continue regardless of the consultations on the operational impacts of the hydroelectric projects. The resulting Section 10

permits describe the efforts being implemented to avoid and minimize the effects that hatchery-reared fish may have on Endangered Species Actlisted salmonids. These efforts include protocols for adult collection and spawning, rearing and release strategies, fish health management programs, and environmental monitoring. These protocols are expected to be followed for all hatchery stocks and would equally benefit unlisted fish species.

In addition to the PUD-funded hatcheries, the Leavenworth National Fish Hatchery Complex releases several million spring-run chinook salmon each year, as mitigation for the construction of the Federal hydroelectric projects upstream of Wells Dam. Although the hatchery production increases the number of fish migrating from (and returning to) the Mid-Columbia River, they can also contribute to a decline in wild fish populations. General impacts of hatchery programs of wild fish populations are presented in Section 4.2.1.1, Endangered Anadromous Salmonid Species – Hatchery Production). Although there is unlikely to be changes in hatchery production due to the potential impacts to unlisted species, hatchery production could be reduced under Alternatives 2 and 3 if such production is likely to jeopardize the continued existence of the listed species (see discussion above under harvest).

Habitat Quantity and Quality

Mid-Columbia River fish runs have been substantially impacted by habitat degradation due to mining, logging, and grazing activities within the tributaries, particularly in the late 1800s and early 1900s. Although habitat conditions are believed to have substantially improved over the last 100 years, the status of tributary habitat is still a limiting factor to the fish production capabilities of the Mid-Columbia River region. The proposed HCPs prioritize habitat protection and restoration for Mid-Columbia River stocks and provide a mechanism for directing PUD funding towards the prioritized activities. The HCPs provide substantial funds (\$ 46.5 million in 1998 dollars)

to implement habitat improvement activities throughout the Mid-Columbia River region. No PUD funding would be available for habitat protection, restoration, or enhancement under Alternatives 1 or 2.

Additional habitat improvements in the Upper Columbia River Basin have been or are being identified through various local, State, or Federally funded processes. Potential habitat improvements from these processes, however, were not considered in the QAR analyses. The Federal Columbia River Power System biological opinion (NMFS 2000a) and the draft All H Paper (Federal Caucus 2000) also call for extensive offsite mitigation to improve the survival of listed salmon and steelhead populations. Quantifying the potential survival improvements of the various State, Federal, and Tribal habitat actions, outside of those directly incorporated into the HCP process, was not included in the OAR analyses due to the narrow focus on hydropower survival improvements in the QAR assessment. In addition, there is considerable uncertainty of when each of the proposed projects will be implemented and effective. A detailed discussion of tributary and reservoir habitat conditions is presented in Section 3.2.2, Anadromous Fish Resources.

Hydropower

The focus of the proposed HCPs is to minimize the effects of the Mid-Columbia River hydroelectric projects on the anadromous fish species in the region. However, these species are also affected by the four Federal hydroelectric projects on the Lower Columbia River (Bonneville, The Dalles, John Day, and McNary dams) (see Figure 1-1). The operation of these downstream projects is expected to be similar under all three of the EIS alternatives.

Mid-Columbia River Projects

The QAR analyses assume that all five of the Mid-Columbia River hydroelectric dams would be operated to meet the proposed HCP project-specific survival standards. Although Grant

County PUD is not a participating entity in the HCP process, requirements developed through Endangered Species Act Section 7 consultations for the Grant County PUD dams (Wanapum and Priest Rapids) are expected to be similar to the Section 10 consultations for the HCPs for listed species. Therefore, the operation of these dams is expected to be similar for all the EIS alternatives.

The HCPs set long-term standards for passage survival through the Mid-Columbia River PUD projects. The standard at each project is based on achieving no less than 91 percent total project survival for juveniles and adults combined. A rough estimate of fish survival, from each of the Mid-Columbia River tributaries downstream to below Priest Rapids Dam (reach survival) was generated for juvenile spring-run chinook salmon and steelhead.

Although information regarding juvenile passage survivals in the Mid-Columbia River prior to dam construction is unavailable, some data exist for the free-flowing portion of the Snake River prior to the construction of the intervening lower mainstem Snake River dams (Smith et al. 1998). This free-flowing reach consists of approximately 318 miles of the mainstem Snake River upstream from Ice Harbor Dam. Applying Snake River pre-dam survival rates to specific Mid-Columbia River reaches (from each of the Mid-Columbia River tributaries to a point below Priest Rapids Dam) results in average pre-dam juvenile reach survival estimates of between 98 and 99 percent. Although these estimates are based on limited data, from a different river and with different fish stocks, NMFS believes that they represent appropriate estimates of pre-dam survival.

Lower Columbia River Projects

The historic passage survival estimates compiled through the Plan for Analyzing and Testing Hypothesis (PATH) process were used to estimate average base period survival through the section of river from the McNary Dam through the Bonneville Dam (Peters et al. 1999). The average per project survival (87 percent) from

Lower Granite through John Day projects was assumed for survival through the two lower river dams (The Dalles and Bonneville). McNary and John Day project survival was assumed to be equal to the average of the Mid-Columbia River projects (85 percent). The resulting aggregate estimate of in-river survival from McNary to Bonneville was 51.5 percent.

A number of options for configuring or operating the Federal hydroelectric projects on the lower mainstem of the Columbia River are under consideration with respect to meeting the survival objectives of the biological opinion for the Federal Columbia River Power System (see Appendix E). The QAR assessed the survival benefits to the Upper Columbia River Evolutionarily Significant Units of spring-run chinook salmon and steelhead, under the assumption that these objectives are met at the Lower Columbia River projects. These survival benefits were combined with the survival benefits resulting from the implementation of the HCPs to determine the overall benefit of the combined measures. The OAR assessed whether these combined measures would be adequate to meet the extinction risk and the recovery criteria for the Upper Columbia River Evolutionarily Significant Units, under different assumptions about future climate and environmental conditions.

Climate and Environmental Conditions

In recent years, theories regarding the potential effect of climate and environmental cycling have gained considerable attention. The available data series for Upper Columbia River spring-run chinook salmon dates from the late 1950s. A set of alternative future climate and environmental scenarios was developed based on this information, using differential analytical time periods.

Three different scenarios reflecting the range of possible future climate conditions were the focus of QAR modeling assessments for spring-run chinook salmon. The first major scenario assumes that background survival conditions

estimated for the years since 1970 reflect the year-to-year variation that will be experienced by Upper Columbia River spring-run chinook salmon in the future. This scenario assumes that the low return rates of the 1990s will be balanced to some extent by higher returns, such as those experienced in the early 1970s.

A second major scenario reflects the assumption that there has been a major downward shift in climate and environmental conditions in recent years, possibly as an effect of long-term natural cycling. This scenario assumes that recent climate regimes (brood years 1980 through 1994) and associated spawner/recruit ratios would persist well into the future.

A third scenario, using the full data set, reflects survival rates observed over the last 30 years (mid-1960s to mid-1990s) and addresses the hypothesis that long-term cycling in North Pacific ocean and atmospheric conditions has an important effect on salmon survival. In particular, associations between an index of North Pacific oceanographic and atmospheric conditions (the Pacific Decadal Oscillation index) and salmon production have been postulated. This index is characterized by a 30-year cycle, with a major change from positive to negative conditions observed in the mid-1970s. However, returns in the last 3 years (2000 through 2002) suggest that the ocean and/or climate conditions might be shifting back to levels observed during the 1960s.

Action Analysis

A number of specific actions to improve the survival of spring-run chinook salmon and steelhead have been implemented in the basin or are under consideration. These actions would occur under all three of the EIS alternatives. Additional actions would be implemented to improve the survival of Endangered Species Actlisted species passing Wells, Rocky Reach, and Rock Island dams under Alternative 2. Similar additional actions are expected under Alternative

3 (the HCPs), although the dam passage survival improvements would also be provided to the unlisted anadromous species.

While the survival improvements under each of the alternatives would primarily focus on passage conditions at hydroelectric dams, the contribution of the proposed HCP-funded habitat improvements was also considered in the OAR analyses. These analyses also assume that the survival goals set forth in the HCPs also apply to the Wanapum and Priest Rapids dams, even though these goals will be established through a separate Section 7 consultation. The primary purpose of the QAR was to determine the survival improvements necessary for protecting and recovering wild Upper Columbia River spring-run chinook salmon and steelhead and intentionally did not assess the effects of the longterm supplementation (hatchery) program included as part of the HCPs. Supplementation was not included because of the potential impacts that it can have on naturally spawning populations, as well as the uncertain effectiveness of supplementation to recover and maintain natural production levels, which is NMFS's intent in the application of the Endangered Species Act regulations.

Recovery of wild Upper Columbia River springrun chinook salmon and steelhead populations will require improved survival throughout the life cycle. The focus on hydropower actions in the analysis reflects the genesis of the QAR effort, to provide analytical tools to use in the assessment of proposed actions at the Mid-Columbia River projects. That fact does not mean that the full burden of achieving survival rates sufficient to recover and sustain natural production would be the sole responsibility of the PUDs. The Upper Columbia River stocks are also subject to hydroelectric dam passage mortality in the Lower Columbia River, due to the four mainstem Federal hydropower projects. Therefore, potential survival changes were assessed given a range of possible scenarios for configuration and operation of the lower river projects.

Interim Recovery Goals and Extinction Risks

Results of the modeling exercise support the contention that hatchery spawner effectiveness is a key uncertainty relative to the level of survival improvements necessary to meet extinction risk and recovery criteria for steelhead. There are two basic rationales supporting the sensitivity analysis of hatchery effectiveness: observations of spatial and temporal differences between hatchery and wild steelhead spawning in the Upper Columbia River tributary streams, and study reviews of the relative effectiveness of hatchery spawners throughout the Columbia River Basin.

Natural stock productivity was evaluated under four alternative assumptions regarding hatchery effectiveness:

- hatchery spawners being equally effective as wild spawners;
- hatchery spawners being 75 percent as effective as wild spawners;
- hatchery spawners being 50 percent as effective as wild spawners; and
- hatchery spawners being 25 percent as effective as wild spawners.

Achieving the proposed HCP passage survival standards will require substantial survival increases over recent historical (1976 to 1996) survival levels to achieve the interim recovery goals for steelhead. Even if the HCP survival standards are achieved, hatchery production would be utilized to partially compensate for the remaining unavoidable project mortality. The remaining impacts are to be mitigated through habitat improvements specifically aimed at increasing the production and survival of anadromous fish populations upstream of the PUD dams – including listed spring-run chinook salmon and steelhead.

Over the long term, Endangered Species Actlisted stocks must be self-sustaining without support from artificial efforts, such as hatchery supplementation. Although not analyzed in the QAR, artificial supplementation is specifically recognized as an important short-term tool to maintain stocks while survival conditions improve to levels that will allow for selfsustaining natural production.

In the case of Upper Columbia River spring-run chinook salmon, supplementation programs might be needed to boost return rates up to the proposed interim recovery goals, because of the extremely low numbers of returning adults produced from wild, natural-spawning fish in recent years. In addition, it is expected to take several years for hydropower and habitat-based survival rates to improve to levels capable of achieving the interim recovery goals.

Steelhead returns into the Upper Columbia River are heavily dominated by returning hatchery fish. Until recently, returning hatchery adults spawning in the wild were predominantly of Wells Hatchery stock, which is considered by NMFS to be negatively influencing the long-term health and survival of wild steelhead. As a result of consultation efforts, however, the Upper Columbia River steelhead hatchery programs are in transition to locally adapted broodstocks.

Due to long-term uncertainty associated with the effectiveness of hatchery supplementation, the QAR analyses did not incorporate continued supplementation as envisioned under the proposed HCPs. However, other HCP actions such as dam passage survival and tributary habitat enhancements were considered in the QAR analyses. In addition, the QAR also assumed that the survival improvements called for at the hydroprojects and tributary enhancements occur instantaneously. In fact, it may take several years or, in some cases, a decade or more before the survival benefits of certain actions (e.g., habitat improvements) are fully realized. Continued supplementation with an appropriate broodstock

represents an important factor to consider when assessing alternative recovery actions.

Modeling Results

The QAR modeling assessed the likely survival improvements resulting from implementation of the HCPs, and whether additional survival improvements would be necessary to meet the extinction risk and interim recovery criteria for the Endangered Species Act-listed stocks. The analyses included the potential benefits from achieving similar survival rates at the Lower Columbia River hydroelectric projects, and the overall effects of future climate/environmental conditions on the recovery process.

Mid-Columbia River Projects

Based on juvenile survival rates of 86 to 88 percent per project for the 1980 to 1994 brood years (the most conservative data set), achieving the proposed HCP passage survival standards would increase Mid-Columbia River reach survival by 16 to 25 percent for steelhead, and by 21 to 35 percent for spring-run chinook salmon. The range in these estimates accounts for the differences in the number of Mid-Columbia River PUD dams that each population migrates past). Additional survival improvements through tributary habitat funding under the proposed HCPs would increase survival by an additional 6 to 10 percent for both spring-run chinook salmon and steelhead. However, because the Endangered Species Act focus is on recovering self-sustaining wild populations in the absence of hatchery support, the assumed 7 percent per project survival increases from supplementation were not added into the model. Although supplementation provides additional returning adult fish, these fish do not necessarily contribute to the rebuilding of naturally spawning wild populations.

Despite these projected survival improvements, the QAR results indicate that additional survival improvements, outside those proposed under the HCPs, would be necessary to achieve extinction risk/recovery criteria, using the most conservative data set (brood years 1980 to 1994). However, using a broader range of data (since the early 1960s), the HCP survival benefits alone are likely sufficient to exceed the levels necessary to meet the interim recovery goals and the 100-year extinction risk criteria (less than 1 percent chance of having no spawners at 100 years).

Lower Columbia River Projects

Under the most conservative data set (brood years 1980 to 1994), additional survival improvements on the order of 20 to 50 percent would be required for spring-run chinook salmon at the Lower Columbia River dams to meet the extinction risk criteria. Steelhead results were similar, but were additionally complicated by basic uncertainties regarding hatchery fish spawning effectiveness. By adding the Lower Columbia River hydroelectric project survival improvements, the probability of meeting the risk/recovery criteria is significantly improved.

The biological opinion for the Federal Columbia River Power System (NMFS 2000a) included reasonable and prudent measures that are expected to improve production and survival during other life cycle stages. NMFS has concluded that implementation of these reasonable and prudent measures would not likely jeopardize the continued existence of the listed species.

Climate and Environmental Conditions

The modeling results indicated that the largest increases in survival necessary to meet risk/recovery criteria were required if the most conservative climate conditions (brood years 1980 through 1994) were assumed to persist for the next 100 years. Under the alternative assumption that future background survival conditions would reflect the range experienced by the 1970 to 1994 brood years, the proposed HCPs' survival improvements for spring-run chinook salmon runs are expected to approach or exceed that necessary to reduce the extinction risk at 100 years to below 5 percent. However, based

upon long-term historical data (1960s through 1990s), achieving the HCP survival goals at the Mid-Columbia projects alone meets the requirements for reaching the interim recovery goals and extinction risks criteria (less than 1 percent risk of no spawners at 100 years).

All three spring-run chinook salmon populations modeled had high long-term (100-year) extinction risks under the assumption of continued low return per spawner ratios using the most conservative data set. Regardless of which data set is used, model runs based on data from the Wenatchee and Entiat River populations showed those populations to be at the highest risk. The model analyses indicate a substantial risk of extinction (using the most conservative data set) over the next 25 to 50 years, assuming no hatchery supplementation, HCP implementation and Lower Columbia River mainstem survival improvements, or positive climate and environmental changes.

Hatchery Production

A set of model runs was made under the assumption that short-term supplementation could successfully boost return levels up to the proposed interim recovery goals. Once the interim recovery standards were achieved, supplementation was ended. Analysis of Alternatives 2 and 3, with respect to Endangered Species Act objectives, required an assessment of the ability of a population to sustain itself in the absence of long-term supplementation or other artificial support. As a result, it was necessary to run the QAR models with the assumption that short-term supplementation would be suspended after interim recovery population levels were achieved. Although these model runs assumed that short-term hatchery supplementation would cease after the interim recovery goals were met, supplementation under the HCPs would not be suspended unless monitoring information indicated a significant detrimental impact to Endangered Species Act-listed species. For

comparison purposes in the EIS, hatchery production under Alternative1 would continue regardless of species recovery status.

For this analysis, the short-term extinction risks were represented by projections at 10 and 25 years, while long-term risks were represented at 75 and 100 years. The extinction risks over the long-term were almost equal to the projected risks in the absence of short-term supplementation, although, for a period of time, short-term supplementation was able to sustain production even under the most conservative climate and survival conditions (experienced by the 1980 to 1994 brood years). Improvements in passage, habitat, and climate conditions would be necessary to allow for sustainable natural production in the absence of long- or short-term hatchery supplementation.

Other Factors

Except for the direct and off-site mitigation measures prescribed in the Federal Columbia River Power System biological opinion and the habitat measures included in the HCPs, other habitat improvement measures and recovery projects were not specifically included in the QAR analyses. The overall uncertainty concerning the location, timing, and extent of these recovery projects results in the inability to adequately quantify the potential benefits for inclusion in the QAR analyses. However, these measures are expected to improve production levels and survival of naturally spawning stocks. As with the measures prescribed in the Federal Columbia River Power System biological opinion (NMFS 2000a), these programs are independent of the HCPs, and would therefore occur under all the EIS alternatives.

The QAR analyses did not include the expected benefits of changes to the hatchery programs in the basin. Although hatchery production can play an important role in addressing particular recovery issues, hatchery supplementation is not considered in the assessment of the long-term sustainability of a listed species. Changes in hatchery programs in the future are expected to minimize the potential impacts on naturally spawning populations.

The QAR assumed that harvest rates experienced by the 1980 to 1994 brood years would continue into the future. Harvest rates are dependent on the abundance of returning adult fish, as well as the mixture of hatchery and naturally spawning fish. They are also expected to change from year to year, as well as from changes in hatchery supplementation and the ability of naturally spawning populations to be self-sustaining. However, recent harvest rates (with the exception of the last few years) were typically below the average used in the QAR analysis.

Cumulative Effect by Evolutionarily Significant Unit

The combined effects of the potential survival improvements from the Lower Columbia River Federal hydropower projects and those that could be gained by meeting the proposed HCPs' survival standards can be calculated by multiplying the estimated survival levels in each section of the river. The QAR results indicate that the greatest survival improvements are needed for the Wenatchee River spring-run chinook salmon and the Methow River steelhead populations. Therefore, using these two populations as surrogates for the larger Upper Columbia River Evolutionarily Significant Units provides a conservative basis for determining the potential cumulative effects of the proposed HCPs.

Spring-Run Chinook Salmon

Under the most conservative assumption (future survival conditions would be similar to those experienced by the 1980 to 1994 brood years), none of the EIS alternatives alone are expected to be sufficient to meet the established extinction risk or recovery criteria. Even with the improvements called for in the Federal Columbia River Power System biological opinion (NMFS)

2000a) (including the benefits of off-site mitigation), none of the alternatives would result in meeting these criteria for all populations under this conservative assumption. The analysis also showed that even removal of the Mid-Columbia River dams would fail to meet these recovery targets, using these same conservative future survival assumptions.

Under this combined scenario (lower river and HCP survival improvements), an additional 7 percent survival improvement would be required to meet the 100-year extinction criterion (less than 1 percent chance of no spawners at 100 years). In addition, substantially greater survival improvement (on the order of 100 percent) would be required to meet the interim recovery criteria under this scenario.

Using a broader-based data set (assuming future environmental conditions similar to those experienced since 1970), the combined effects of the Federal system improvements and the proposed HCP actions would exceed the 100-year extinction criteria for the Upper Columbia River spring-run chinook salmon population. Although Alternative 2 would likely result in the same project passage survival rates, it does not include the PUD-funded habitat improvement program. As a result, it is uncertain if the 100-year extinction criterion would be met with the combination of Alternative 2 and the Federal system improvements under future conditions similar to those that existed for the 1970 to 1994 brood years. However, neither Alternative 2 nor 3 (combined with Federal system improvements) would provide the additional survival improvements necessary to meet the interim recovery criteria, although additional survival needs would be greatly reduced (an additional 22 to 27 percent survival improvement needed, as opposed to the approximately 100 percent improvement required using the 1980 to 1994 brood year data set).

Assuming that future climate conditions reflect the entire historical spring-run chinook data set (since the 1960s), the Upper Columbia River spring-run chinook salmon are expected to meet both the extinction risk criteria and the interim recovery abundance level under the combination of actions in the proposed HCPs and the survival improvements on the Lower Columbia River. Similarly, the survival improvements likely to occur under Alternative 2 (combined with the Federal system improvements) would also meet extinction risk and recovery criteria under these same future climate conditions.

Using the entire data set assumes that future climate and environmental conditions will result in some good survival years (similar to those observed in the 1960s) and some poor survival years (similar to the 1980s through the mid-1990s). The adult returns observed in the last several years have been similar to those observed in the 1960s. Adding the adult returns in 2000 and 2001 (1995 and 1996 brood years) to extend the 1980 to 1994 data series results in mean return per spawner rates similar to the 1970 to 1994 data series.

Thus, the risk of extinction and the probability of reaching the interim recovery goals are dependent on the assumption of future environmental conditions and consequently, which part of the existing data set is used. Under the most conservative view of future environmental conditions (using the 1980 to 1994 brood year data set), even the removal of the Mid-Columbia River dams would not allow the achievement of acceptable risk of extinction or meeting the interim recovery goals. In contrast, if the entire historical data set (1960 to 1994 brood years) better represents future environmental conditions, the extinction risk criteria would be met for each of the populations and substantially fewer additional survival improvements would be needed to meet the interim recovery criteria for each of the populations. Similar results are expected for Alternatives 2 and 3, although the PUD-funded habitat improvement program of Alternative 3 is expected to improve the chances

of meeting the criteria under any of the future conditions modeled.

Steelhead

The QAR assessment for Upper Columbia River steelhead indicates that the proposed HCP survival improvements alone would not meet survival improvement requirements for satisfying either the extinction risk or the interim recovery level criteria under a range of possible hatchery spawner effectiveness assumptions (25 to 100 percent). However, the projected survival improvements from the proposed HCP actions and those from the Lower Columbia River survival improvements would meet both the extinction risk and interim recovery criteria if hatchery spawner effectiveness is 25 percent or less. If hatchery spawner effectiveness is between 25 and 50 percent, the projected survival improvements of the combined HCPs and Federal system improvements meet the 100-year extinction risk criterion. However, substantial improvements would be needed to achieve the interim recovery objectives. The extinction risk and the recovery criteria would not be met at 75 percent spawning effectiveness or greater, if poor ocean and climate conditions persist. If hatchery fish are 100 percent as effective at naturally reproducing as wild fish, then the combined survival improvements do not meet either set of criteria. Under these criteria, similar results are expected for Alternative 2, although the lack of the PUD-funded habitat improvement program is expected to somewhat further reduce the likelihood of recovery.

The steelhead model runs do not include long-term (7 percent) hatchery supplementation for summer-run steelhead. Life-cycle model runs incorporating long-term supplementation indicate that supplementation alone could withstand the downturn in survival even under conservative brood year climatic regimes. However, when using long-term supplementation, a high fraction of returning spawners would be of hatchery origin. The long-term effects of such interactions on the relative fitness of wild spawners are not

known. Efforts are underway to minimize negative impacts of hatcheries in the Upper Columbia River through improved broodstock management and selective fishing techniques.

Other Cumulative Effects

Despite the continued effects associated with the lower river projects, recent improvements to fish passage facilities have resulted in substantial reductions in these impacts. Between 1996 and 1999, structural improvements at Lower Columbia River projects have resulted in a 30 percent decrease in turbine passage, which equates to about a 5 percent increase in fish survival at each dam (BPA 2001). Further improvements in fish passage structures in the lower river are expected to continue, although it is uncertain whether the survival will continue to improve at this same rate.

The cumulative effects suggest that the Mid-Columbia River projects under the proposed actions (including dam removal) would not meet the extinction and recovery criteria unless accompanied by substantial improvements in the overall life-history survival conditions. However, substantial survival improvements are expected to occur through fish passage modifications in the hydroelectric system. In addition to the cumulative effects of other hydroelectric projects, other water-related projects in the basin are expected to have substantial effects on anadromous species.

Efforts to reduce the predation rates on juvenile salmonids have had, and will continue to have, substantial influence on the salmon recovery processes. By 1997, the predator control program in the Lower Columbia River had reduced predation rates by northern pikeminnow to an estimated 62 percent of the pre-program levels. Efforts in more recent years to address the predation of salmon and steelhead smolts by Caspian terns in the Columbia River estuary have resulted in substantial predation reductions. Caspian terns nesting on Rice Island were

estimated to have consumed about 10.8 million juvenile salmon in 1998, or about 11 percent of the total outmigrating salmon and steelhead. In 1999, terns displaced from Rice Island to East Sand Island consumed an estimated 41 percent fewer salmonids than those remaining on Rice Island (Roby et al. 2000). Preliminary data in 2001 indicated that no terns nested on Rice Island, and the avian predation was estimated at about 4.4 million smolts (NMFS 2002b). This represents a 59 percent reduction in predation since 1998. Continued implementation of the predator control measures at the Mid-Columbia River projects is expected to further reduce both fish and avian predation levels.

The U.S. Army Corps of Engineers is seeking regulatory approval and permits for a proposed Columbia River Channel Improvement Project. This project would deepen the navigation channel of the Columbia River, from its mouth to the mouth of the Willamette River, by 3 feet to a minimum depth of 43 feet, as authorized by Congress. A biological assessment of the proposed channel deepening determined that the project is not likely to have significant adverse impacts to the Endangered Species Act-listed species (chinook and sockeye salmon and steelhead) in the Columbia River system. NMFS and USFWS provided the biological opinions on the project, affirming that the project is not likely to jeopardize the continued existence of Endangered Species Act-listed species in the Columbia River System (NMFS 2002e; USFWS 2002).

5.7.2.2 Other Listed Fish Species

Limited numbers of bull trout have been observed passing through the adult fishladders each year. These numbers range between 16 and 89 in recent years at Wells Dam (Snow 1999), 83 to 183 at Rocky Reach Dam, and 53 to 83 at Rock Island Dam (Hays 2002 personal communication). Although there are no data concerning downstream passage of juvenile or adult bull

trout, they would be restricted to using the same upstream and downstream routes available to the anadromous salmonids that pass the project.

Although bull trout are occasionally observed passing the projects, there is no indication that the Mid-Columbia River populations would be affected by downstream hydroelectric projects. The 2001 radio-telemetry study in the Mid-Columbia River area found that none of the radio-tagged fish passed downstream of Wanapum Dam (Stevenson and Hillman 2002).

Radio-tagging studies indicate that some individuals spent considerable periods of time residing in the mainstem Columbia River. Bull trout that reside in the Columbia River could be affected by water quality changes as a result of upstream hydroelectric projects. Those individuals or populations that reside in the tributary streams would be affected by habitat improvement activities associated with Federal, State, Tribal, or local community programs. Although many of these programs in the Mid-Columbia River area are guided by salmon recovery initiatives, the improvements are expected to benefit other tributary species (especially other salmonids, such as bull trout). These activities would be in addition to those funded by the Tributary Conservation Plans included in the HCPs, and would occur under all three EIS alternatives.

Bull trout is not a Plan species in the proposed HCPs; however, Section 7 consultations under the Endangered Species Act are being conducted between FERC and USFWS for the protection of bull trout relative to the operation of the Mid-Columbia River projects under Alternatives 2 and 3. In addition, NMFS would consult with USFWS over the issuance of Section 10 permits under Alternative 2 or 3. These consultations are expected to provide additional protection to bull trout in the Mid-Columbia River area, beyond that occurring coincidental to the salmon recovery programs provided through the action alternatives. Radio-telemetry evaluations are

currently underway to assess the behavior patterns of adult bull trout to determine the distance they migrate and the number of projects that they pass. Although anadromous behavior can occur in bull trout populations, there is no information suggesting that the Mid-Columbia River bull trout populations are anadromous.

5.7.2.3 Other Plan Species

The biological requirements for the other Plan species are similar to those discussed for the Endangered Species Act-listed fish species.

These populations are generally subject to the same environmental conditions that constitute the cumulative impacts to the listed fish. Although improvements in passage conditions at the Mid-Columbia River projects and other downstream projects for the listed species are expected to have similar benefits for these unlisted Plan species, there might be some differences in the cumulative effects based on the types of improvements.

Sockeye and fall/summer-run chinook salmon tend to have greater potential for descaling and injury rates than steelhead and spring-run chinook salmon when passing through turbine intake screen bypass systems. There are also limited data concerning the effects of these bypass systems on coho salmon because of the low number of fish in the project area and the limited studies conducted. However, fish passage improvements at the Lower Columbia River projects are expected to benefit all of the Plan species because of the greater number of listed species (and resulting variation in passage requirements) that must be considered when implementing protection measures at these projects. These lower river fish passage improvements would occur for all alternatives.

The increased use of spring spill at the Mid-Columbia River projects for listed steelhead and spring-run chinook salmon under Alternative 2 would also likely provide greater benefits to sockeye and yearling summer chinook salmon, compared to Alternative 1. However, increased

spring spill to protect the listed stocks would not provide additional benefits to summer-migrating subyearling chinook. Increased summer spill levels to protect this ESU would occur only under Alternative 3. Spill programs at the Lower Columbia River projects will most likely continue to cover both the spring and summer migration seasons, providing cumulative benefits to all the Plan species under all three EIS alternatives.

Unlike management under Alternatives 1 and 2, the off-site mitigation funding provided by the HCPs under Alternative 3 compliments the habitat improvement initiatives as part of the reasonable and prudent alternatives of the Federal Columbia River Power System biological opinion (NMFS 2000a), thereby increasing the cumulative benefit to all the Plan species. Although these Federal projects would occur under all the alternatives, a greater overall cumulative benefit to all Plan species is expected under Alternative 3 because of the habitat improvement funding provided by the Mid-Columbia River PUDs.

5.7.2.4 Other Fish Species

With the possible exception of increased total dissolved gas levels resulting from spill at the Mid-Columbia River projects, project operations would have little effect on resident populations in the Lower Columbia River. The resident fish in the basin tend to occur in discrete populations bounded by the hydroelectric projects and accessible tributary streams. Although there are opportunities for fish to move between these populations, this movement is typically greater in a downstream direction as a result of the involuntary entrainment in water passing the dams. Upstream fish movements require a voluntary behavior characteristic within the populations and do not occur inadvertently. The downstream displacement of resident fish might also occur during high-flow spill periods under existing conditions. Although there are some data concerning the abundance of resident fish

populations in the system, there is little or no information concerning the effects of the hydroelectric system operations on these populations or the population interactions between reservoirs.

Lamprey and sturgeon are migratory species that might be subject to cumulative effects throughout the hydroelectric system, although there are limited data on their migration behavior in the Mid-Columbia River area.

Juvenile lamprey are susceptible to impingement on turbine intake guidance screens. Although Rocky Reach Dam is the only Mid-Columbia River project that currently uses these devices to improve fish guidance efficiencies (at Turbine Units 1 and 2 only), they are used at other Lower Columbia River dams. At Rocky Reach Dam, fish passage studies in the 1980s and early 1990s showed that juvenile lamprey were traveling below the screens (Peven 2002 personal communication). The projects also impede the upstream migration of lamprey, and the effectiveness of the adult fishladders at passing lamprey is unknown.

The cumulative effects of project operations on lamprey are expected to be similar for all three EIS alternatives. Similarly, habitat improvement projects associated with the reasonable and prudent alternatives in the Federal Columbia River Power System biological opinion (NMFS 2000a) could improve tributary spawning and rearing conditions for lamprey under all the alternatives. However, the additional PUDfunded habitat improvement projects would occur only under Alternative 3.

Sturgeon are rarely observed using the fishladders and are thought to exist in relatively small, isolated populations within the reservoirs. Therefore, project operations under any of the alternatives are not expected to result in substantial cumulative effects on sturgeon. However, a tagging study in 2001 reported one sonic-tagged fish that moved from the Wells Dam

tailrace to downstream of Rocky Reach Dam (RL&L 2002). The overall extent of such migrations (whether sturgeon pass any Lower Columbia River projects) is unknown. The majority of the habitat improvement projects that would occur in the basin under all three EIS Alternatives, as well as the PUD-funded projects associated with Alternative 3, would likely occur in the tributary areas, and would therefore not substantially affect sturgeon.

5.7.3 WATER RESOURCES (QUANTITY AND QUALITY)

5.7.3.1 Water Quantity

The three Mid-Columbia River dams have limited capabilities for water storage. Under all the alternatives, these run-of-the-river reservoirs would continue to pass water volumes discharged from the Grand Coulee and Chief Joseph dams upstream. Water flows in the Columbia River downstream from the project area would continue to experience minor fluctuations based on turbine usage and spillway releases. Monthly flows and peak flows would not be affected. Any operational changes and mitigation measures implemented under any of the alternatives to decrease salmonid mortality through the dams would have negligible effects on flows in the Columbia River system.

Although reservoir drawdown would increase water velocity in the reservoirs, it would not necessarily change reservoir discharge rates. In addition, there are no specific water management changes expected to occur in the Columbia River that would substantially affect water quantity levels in the project area.

5.7.3.2 Water Quality

The run-of-the-river projects of the Mid-Columbia River generally convey unpolluted, high-quality water from the upper reaches and tributary rivers to downstream reaches of the

Columbia River. Marginal improvements are likely as Ecology implements TMDLs for specific water quality parameters that exceed standards, and as other agencies and watershed protection organizations work to enhance water quality and improve instream flows.

One water quality parameter that could be affected by Alternatives 2 and 3 is total dissolved gas. There is a cumulative increase in the levels of total dissolved gas supersaturation as a result of spilling from the series of dams in the system. Thus, any reduction in total dissolved gas achieved at Mid-Columbia River dams would benefit water quality downstream. Conversely, if spills are increased to facilitate juvenile salmonid migration, downstream total dissolved gas supersaturation could increase.

As bypass systems (which increase survival and reduce spill requirements) for the Rock Island and Rocky Reach projects are developed over time, it is expected that total dissolved gas levels would decrease in the Mid-Columbia River under Alternatives 2 and 3. Similarly, the potential development of effective dissolved gas abatement structures at the projects could further reduce total dissolved gas levels. Further research would better define the risks of gas bubble disease and other adverse effects caused by total dissolved gas supersaturation under different conditions. Although increased spill could occur under Alternatives 2 or 3 to improve juvenile fish passage, it would be limited by the total dissolved gas water quality standards. It is unlikely that the standards would be changed unless it is demonstrated that risks of adverse effects to fisheries and water quality are acceptable.

There are no other water quality effects that would occur from implementation of Alternatives 2 and 3. In addition, there are no substantial water quality changes expected to occur in the Columbia River that would affect water quality in the project area.

5.7.4 VEGETATION

There are no planned vegetation changes in the Mid-Columbia River region of the project area under any of the alternatives that would affect vegetation elsewhere within the Columbia River Basin. Alternative 3 additionally includes the expected increased riparian habitat restoration in the four tributaries (Methow, Okanogan, Entiat, and Wenatchee) from funding through the Plan Species Account, which would not occur under Alternatives 1 and 2. These vegetation restoration projects would help to provide increased riparian habitat continuity throughout each of the tributaries. Other ongoing Federal, Tribal, regional, State, and local programs would also aid in riparian restoration in tributaries that flow into the Columbia River. These programs include watershed enhancement, vegetation restoration, and land acquisition that support conservation efforts aimed at preserving native vegetation, increasing the recruitment of large woody debris into streams, and increasing shading over coldwater streams.

An exception where loss of vegetation would occur is the potential for drawdown associated with Alternatives 2 or 3. Drawdown could occur within the reservoirs of any of the three hydroelectric projects. Permanent or seasonal drawdown would result in a loss of shoreline vegetation. The loss would be permanent under seasonal drawdown because the fluctuating water levels would prevent colonization by plants, but short term if a permanent drawdown were to occur. Refer to Section 4.4, Vegetation for a discussion of drawdown effects on vegetation in the project area. These effects include the potential for noxious weed invasion and increased sedimentation and loss of native soils when drawdown occurs.

If drawdown were to occur elsewhere in the Columbia River, there would be no effects to vegetation in the Mid-Columbia area or the four

tributaries. Drawdown would not occur at any of the three dams under Alternative 1.

5.7.5 WILDLIFE

None of the fish conservation measures associated with Alternatives 1, 2, or 3 affect wildlife, except for the avian predator control activities that occur under all alternatives. Further increases in avian predator control that may occur throughout the Columbia River basin could affect piscivorous bird populations in general. However, current trends in populations of these birds indicate expanding populations (APHIS 2001). Intensification of predator control activities may curtail population growth, but is not expected to result in population reduction for any of the piscivorous bird species in the basin unless substantial efforts greater than that predicted under any of the alternatives were to occur.

Other alternative effects on wildlife include the effects of drawdown, which could potentially occur under Alternative 2 or 3. Drawdown would result in a decrease and change in wildlife populations residing in or using shoreline habitats along the Mid-Columbia River. Permanent drawdown would temporarily affect wildlife food access and cover, particularly for shoreline wildlife such as amphibians and small mammals. Wetland-dependent wildlife would move to newly formed wetlands, and the existing wetlands may dry out over time. Seasonal drawdown would impact wildlife dependent on wetland habitat. The changing shoreline conditions would have a greater effect on resident species than on migratory species because of the difficulty to residents of having to adjust to a seasonally changing water level. Migratory birds would have the advantage of departing the area at specific times of the year, and thereby having a similar water level each season of the year the birds are visiting the area.

The potential for drawdown at other sites is not likely to affect waterfowl in the project area

because these reservoirs are greater than 10 miles distant from the project area and would not immediately affect wildlife species use.

The habitat restoration and conservation easement projects planned in the Columbia Basin will help to increase wildlife populations in the basin. The projects most advantageous to wildlife are primarily those associated with riparian habitat restoration.

5.7.6 LAND OWNERSHIP AND USE

There are no projected changes to land ownership, land use, or zoning under Alternatives 1 or 2. Under Alternative 3, however, the Plan Species Account would be used to purchase land or water rights for conservation or restoration activities. This could result in some land use changes in limited reaches within any of the four tributaries. Alternative 3 would not affect land use in the portion of the project area associated with the dams.

An exception would be drawdown, which could occur under either Alternative 2 or 3. The effects would occur largely to landowners and businesses dependent on water sources. Under drawdown, there would be a decrease in available water for crop production and commercial industry, which would affect livelihoods of farmers and other workers in the Mid-Columbia region, but should not affect agriculture or industry outside the region, such as the Upper Columbia or Lower Columbia River basins. Over the short term, within the Mid-Columbia River Basin, farms may lay fallow and industries may close until alternative crops and businesses develop that are not as dependent on water. Land ownership could change and land values may also decrease if drawdown occurs. There is a possibility that zoning may change dependent on whether agricultural fields are then used for other purposes.

The Federal, Tribal, State, and local programs designed to help salmonid recovery in the

Columbia River Basin would not affect land uses in the Mid-Columbia area, except for any land acquisition or restoration projects that may occur in the tributaries. These projects would occur under any alternative, and effects are described under Section 4.6.1.2, Associated Tributaries. These independent projects are not expected to affect any land uses in the Mid-Columbia River area.

5.7.7 SOCIOECONOMICS

Under Alternative 1, there are no expected changes in population, employment, and income that would affect or be affected by the overall Columbia River system over the next 50 years. Under Alternatives 2 and 3, drawdown could affect overall employment, particularly in the agricultural industry. Those no longer employed as a result of the loss of agricultural water resources would be expected to search elsewhere in Washington and Oregon for work. This scenario would occur under either permanent or seasonal drawdown and would primarily affect low-income workers, many of whom are minorities.

Other fish conservation measures associated with Alternatives 2 and 3 at the project sites may result in a small increase in hiring of biologists for conducting studies and engineers for designing fish passage structures or helping to increase fish passage efficiencies at existing structures. These effects are not substantial enough to affect socioeconomics in the Columbia River Basin.

Federal, Tribal, regional, State, and local programs developed for salmonid recovery would help to increase fish populations in the Columbia River system. The increased fish populations would aid the fishing and recreation industries, which are dependent on a reliable fish resource. These efforts are independent of the project and would occur under any of the alternatives.

The Plan Species Account under Alternative 3 would help to support these efforts in the Entiat,

Wenatchee, Okanogan, and Methow Rivers. Although land acquisition would not alter employment in the region, riparian restoration would result in the temporary employment of workers as they help to improve habitat conditions in the four tributaries. Because the effort would likely be short-term and not involve a large number of workers, changes in socioeconomics are expected to be minimal and limited to the communities located near the tributaries. No larger socioeconomic effects would occur in the Columbia River Basin as a result of habitat restoration occurring in the four tributaries.

5.7.8 AESTHETICS

Project aesthetics are not expected to be altered by other activities in the Columbia River, and there are no scenery changes within the project area that could affect other activities and facilities outside the project area under any alternative. There are no other planned projects in the vicinity that would degrade visual quality in the basin. An exception would be drawdown, which could potentially occur under Alternative 2 or 3. Permanent drawdown would affect overall aesthetics in the area with a decrease in quality of the visual scenery over the short term (up to 10 years). Visitors may be attracted to other areas in the Columbia River region and elsewhere, which may alter long-term visitor usage. However, with permanent drawdown, once the shoreline is revegetated, scenery effects would return to existing conditions, although a longer and wider shoreline would be visible. With seasonal drawdown, riparian habitat would be reduced or eliminated, and may not be reestablished because of the constantly fluctuating water levels. In this latter situation, effects to scenery would be permanent.

5.7.9 RECREATION

There are no expected changes in recreational uses at the three dams that would affect other

recreational uses or users in the Columbia River system for any of the alternatives. Likewise, there are no anticipated changes in recreational uses throughout the Columbia River system that would affect those uses in the project area. Exceptions are the tributary habitat improvements that would occur under Alternative 3, the potential for project drawdown that could occur under Alternatives 2 or 3, or drawdown that could occur at other dams in the Columbia River. Possible exceptions are described below.

Recreation effects from tributary habitat improvements under Alternative 3 are already described in Section 4.10.3, Associated Tributaries. These effects may include a temporary decrease in access as the tributary construction improvements occur and a potential increase in passive recreation opportunities for viewing new conservation areas or natural resource improvements when the projects are completed.

Effects from project drawdown to recreation users and uses are described in Sections 4.10.2, Alternative 2 and Section 4.10.3, Alternative 3. These effects include a decrease in access and use of recreation facilities that are located at the shoreline of the Columbia River or other recreation boating opportunities within the Columbia River. It is possible that these recreational users could be displaced to other areas of the Columbia River. If drawdown were to occur at other locations in the Columbia River. such as the John Day Reservoir, it is possible that those recreational users could be displaced to areas of the Mid-Columbia River, thereby increasing competition for recreation resources in the project area. However, once water access is reestablished following drawdown, visitation may increase dependent on the extent and quality of fishing and boating opportunities in the project area.

Permanent drawdown may have short-term effects as the vegetation adjusts to the shoreline changes, whereas seasonal drawdown would affect all parks and facilities located along the Columbia River shoreline. These facilities would either be removed altogether or be usable only a portion of the year when water levels rise to predrawdown conditions. However, in both situations, once drawdown occurs, there would be less usable area for boating.

5.7.10 Cultural Resources

Project operations under any alternative would not affect cultural resources in the Mid-Columbia region. One possible exception would be tributary habitat improvements funded through the Plan Species Account, which would occur under Alternative 3. However, these projects would be reviewed independently once identified, with a separate checklist and environmental permitting process to ensure protection of the environment, including cultural resources. Project operations associated with any of the alternatives would not affect any regional plans regarding cultural resources. In addition, there are no regional cultural resource plans that would affect the project alternatives.

Native and hatchery-raised salmon and steelhead are an important cultural resource for Native American Tribes. Any alternative that would result in the reduction of hatchery or wild fish would result in adverse impacts to the traditional cultural resource of salmon. Alternative 1 would not result in any reduction, although the conservation measures associated with Alternative 1 are not as likely to increase fish populations and decrease mortality through the dams. The fish conservation measures associated with both Alternatives 2 and 3 should help to increase wild fish survival. Alternatives 2 and 3 may both result in a decrease in hatchery production levels. For Alternative 3, the review

of hatchery production would occur in 2013 and every 10 years thereafter, whereas for Alternative 2, the reviews are not yet determined.

If a decrease in hatchery production occurs without a simultaneous increase in wild fish populations, then Native Americans would likely have a decrease in the amount of commercial and subsistence harvest of salmon. This effect would occur throughout the Columbia River and affect the several Tribes that reside in the Columbia River Basin.

The Federal, Tribal, State, and local salmon recovery plans, which would occur under any action alternative and are independent of the project, would help to increase production of wild fish, which would be a benefit and occur for all alternatives. These efforts include the Tribal *Wy-Kan-Ush-Mi Wa-Kish-Wit* (also known as Spirit of the Salmon plan), which emphasizes reliance on natural production and healthy river ecosystems. The plan was developed for rebuilding salmon populations upstream of the Bonneville Dam and increasing lamprey and sturgeon populations. The plan was developed to support Tribal harvest.

Alternatives 2 and 3 would help to ensure that the Federal Government's Trust responsibility is implemented in protecting and restoring fish populations, a Native American cultural resource. This includes the habitats needed to support fish resources. In particular, the Plan Species Account associated with Alternative 3 would help to rebuild fish habitat in the four tributaries.

Through implementation of fish conservation measures at the dams, both Alternatives 2 and 3 would help to rebuild fish populations and increase fish survival in comparison to Alternative 1, which would likely result in continuing the existing fish production levels over the next 50 years.

5.7.11 ENVIRONMENTAL JUSTICE

Alternative 1 would have no cumulative effect on low-income and minority populations within and outside of the project area. Under Alternatives 2 and 3, the conservation measures planned at each of the project sites would not affect or change existing employment or demographics of low-income or minority populations either within or outside of the project area. Other components of Alternatives 2 and 3 that may affect low-income and minority workers include the possibility of drawdown, hatchery production changes, and projects funded under the Plan Species Account.

Drawdown is a remote possibility under Alternatives 2 and 3. If drawdown were to occur, irrigation intake structures might no longer be submerged in the project reservoirs, which may affect agriculture and loss of future crops. This effect may result in a decrease of employment opportunities in the Mid-Columbia agricultural basin, which would specifically affect minority and low-income workers. These workers would likely depart the area in search of employment. The displaced workers may move to other areas within the Columbia Basin in search of work, which would increase competition for this type of employment. The significance of this effect

would be evaluated in a separate EIS. Drawdown would not occur under Alternative 1.

Changes in hatchery programs that may result in a decreased production of hatchery fish could occur at any time over the next 50 years under Alternative 2. Under Alternative 3, the review of hatchery production would occur in 2013 and every 10 years thereafter to determine if a decrease in hatchery fish would reduce any detrimental effects that hatchery fish may have on Endangered Species Act-listed fish populations. For comparison purposes, hatchery fish production is assumed to remain unchanged under Alternative 1. A decrease in hatchery production would likely result in fewer and less successful fishing opportunities, particularly for Tribal subsistence and ceremonial fisheries.

Funding for the Plan Species Account proposed under Alternative 3 would help to increase the populations of naturally spawning fish in the four tributaries and passing through the Mid-Columbia River. If successful, minority and low-income populations would have greater fishing opportunities and success. This would help minorities and low-income populations in providing fish for subsistence uses and for Tribal harvests. This benefit would not occur under Alternatives 1 and 2.

5.8 CUMULATIVE EFFECTS SUMMARY

The Federal, Tribal, State, and local salmonid recovery programs that are expected to occur throughout the Columbia River Basin would help to increase wild fish populations in the Columbia River. These recovery programs would occur under Alternative 1, and be in addition to those implemented at the Mid-Columbia River PUD projects under Alternatives 2 or 3. These programs address a wide range of issues affecting salmon populations in the basin, typically focusing on the "All H" (hydropower, habitat, hatcheries, and harvest) strategy.

The recovery programs are expected to:

- return river and stream shorelines to natural riparian conditions over time,
- result in land acquisitions to convert agricultural/industrial shoreline habitat into natural riparian habitat conditions,
- result in hatchery reforms that decrease negative effects that hatchery fish may have on wild fish populations,
- help to evaluate fish harvest and develop reforms to minimize the direct and indirect impacts to listed species,

- increase predator control fishery programs, and
- improve water quality conditions in the Columbia River.

These efforts, along with the additional fish conservation measures associated with Alternatives 2 and 3, are expected to increase the production and survival of wild fish in the Columbia River. Alternative 3 would have the increased advantage of a Plan Species Account to help restore salmonid habitat in the four tributaries associated with the Mid-Columbia River. This program would be in addition to other habitat restoration projects that would occur under all the alternatives, but not funded by the PUDs.

Other environmental effects of the Columbia River Basin recovery programs and implementation of Alternatives 2 or 3 include an increase in native riparian vegetation, increase in wildlife dependent on riparian habitat, a decrease in salmonid predators (piscivorous fish and birds), potential changes in land ownership and use (conversion of land to conservation areas), an increase in employment associated with habitat restoration and commercial and recreational fishing, more natural aesthetic settings in salmonid streams, an increase in passive recreational opportunities (such as hiking and boating), and increased protection of Native American cultural resources, including salmon.

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Chapter 6

References

CHANGES MADE BETWEEN THE DEIS AND FEIS FOR CHAPTER 6

•	New	references	were	added	for	the	FEIS.
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Glossary

CHANGES MADE BETWEEN THE DEIS AND FEIS FOR CHAPTER 7

Additional terms were added, including those used for economics.

7 GLOSSARY

- 303(d) list A list of water bodies that the WDOE has identified as having impaired water quality based on evidence that specific water quality standards have not been met. Section 303(d) of the Federal Clean Water Act requires that states prepare and periodically update these lists and develop controls to bring the water bodies into compliance with standards and protect beneficial water uses (e.g., water supply, cold-water fisheries).
- Adaptive Management The process of monitoring the implementation of conservation measures, then adjusting future conservation measures according to what was learned. Adaptive management can also include testing of alternative conservation measures, monitoring the results, and then choosing the most effective and efficient measures for long-term implementation.
- **Alevin** The life stage of salmonids between hatching and active feeding when the yolk sac is still present, generally equivalent to sac fry or larval stage.
- aMW Average megawatts per hour for every hour in the period from March through September for this project.
- Anadromous Describes the life-history characteristic of a fish species that reproduces in freshwater, migrates to the ocean for some portion of its rearing stage, and returns to freshwater as an adult.
- **Aquatic Macrophytes** Plants that occur entirely immersed within or under water.
- **Artificial Supplementation** Hatchery programs that are used to enhance natural reproduction in the natural environment.
- **Basalt** A fine-grained, igneous rock dominated by dark-colored minerals. Cliffs along the Columbia River Valley are typically formed in basalt.

- Base Flow The normal low flow that occurs seasonally in a river or creek. During a period of run-off from rain or snowmelt, streams rise above base flow levels and then recede to base flows sometime after the runoff event has passed. Base flows are sustained by groundwater discharges or snowmelt that may vary seasonally (e.g., higher base flow in the spring and lower in the summer).
- Biological Assessment A requirement under the Endangered Species Act, to assess the effects of a Federal action on a Federally listed threatened or endangered species. A biological assessment report is prepared by the project proponent and provides existing and projected conditions that affect a threatened or endangered species and the proposed mitigation measures that minimize or avoid impacts to these species.
- Biological Opinion An opinion from USFWS or NMFS as to the effects of a Federal action on a Federally listed threatened or endangered species. A biological opinion is a report that reviews and considers the adequacy of the biological assessment that is initially prepared by the project proponent. The biological opinion includes conservation measures recommended by the agency to protect the listed species.
- **Biological Productivity** Capacity of an ecological system to produce or support a particular population size of an animal (fish) or plant species.
- **Broodstock** Group of fish that are used to provide eggs and sperm to produce a hatchery stock for supplementation purposes.
- Bypass System Structure in a dam that provides a route for fish to move through or around the dam without going through the turbines. See also Juvenile Bypass.

- Candidate Species As defined by the USFWS and NMFS, candidate species are wildlife, fish, or plants being considered for listing as endangered or threatened, but for which more information is needed before they can be proposed for listing.
- Channel Structure Channel structure is formed by river bed roughness elements like bars and bends, in-channel logs or debris jams, bank vegetation, and large rocks. Channel structure is important for channel flow velocities, aquatic habitat, and preventing channel erosion.
- Columbia Plateau Relatively flat region of eastern Washington and northern Oregon formed by vast accumulations of near horizontal flows of basalt lava.
- **Conservation Measures** Actions that a non-Federal property owner voluntarily agrees to undertake when preparing a habitat conservation plan.
- Covered Species Species that have been adequately addressed in an HCP as though they were listed, and are therefore included on the permit or, alternatively, for which assurances are provided by the permittee that such species will be added to the permit if listed under certain circumstances. Covered species are also subject to the assurances of the No Surprises policy. Also referred to as *Plan species*.
- Critical Habitat Specific areas occupied by a species that contain physical and biological features essential to the conservation of the species, and which may require special management considerations for protection. These areas might provide space for individual or population growth, nutritional or physiological requirements, breeding and rearing habitat, or shelter or cover for protection, or they might represent the historical or geographical distribution of the species.
- Cultural Resource Nonrenewable evidence of human occupations or activity as seen in any district, site, building, structure, artifact, ruin, object, work of art, architecture, or natural feature associated with the cultural practices or beliefs of a living community.

- Cumulative Impact or Effect Under NEPA regulations, the incremental environmental impact or effect of the action together with the impacts of past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions (40 CFR 1508.7). Under Endangered Species Act Section 7 regulations, the effects of future State or private activities not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02).
- **Dam** A structure impounding a river.
- Delist To remove from the Federal list of endangered and threatened species (50 CFR 17.11 and 17.12) because such species no longer meets any of the five listing factors provided under Section 4(a)(1) of the Endangered Species Act and under which the species was originally listed (i.e., because the species has become extinct or is recovered).
- **Dissolved Oxygen** The amount of oxygen that is in a solution of water.
- **Drawdown** The distance that the water surface of a reservoir is lowered from a given elevation as water is released from the reservoir. Also refers to the act of lowering reservoir levels.
- **Effect or Impact** Under NEPA regulations, a direct result of an action that occurs at the same time and place; or an indirect result of an action that occurs later in time or in a different place and is reasonably foreseeable; or the cumulative results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions (40 CFR 1508.8). Under Endangered Species Act Section 7 regulations, "effects of the action" means "direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline" (50 CFR 402.02).

- **Embankment** The earthen portion of a dam that is typically filled in after the concrete portion is built to form the reservoir.
- **Endangered Species** A species of plant, fish, or wildlife which is in danger of extinction throughout all or a significant portion of its range.
- Endangered Species Act The Endangered Species Act of 1973, 16 USC §§ 1531 through 1543, as amended and its implementing regulations. Federal legislation which provides a means to ensure the continued existence of threatened or endangered species and the protection of critical habitat of such species.
- Environmental Impact Statement A detailed written statement required by Section 102(2)(C) of NEPA containing, among other things, an analysis of environmental impacts of a proposed action and alternatives considered, adverse effects of the project that cannot be avoided, alternative courses of action, short-term uses of the environment versus the maintenance and enhancement of long-term productivity, and irreversible and irretrievable commitment of resources (40 CFR 1508.11 and 40 CFR 1502).
- Evolutionarily Significant Unit A reproductively isolated animal or fish population that represents an important component in the ecological/genetic diversity evolution of the species. The unit typically has a relatively confined historical or geographical distribution. To be considered an Evolutionarily Significant Unit, a population must satisfy two criteria: (1) it must be reproductively isolated from other population units of the same species, and (2) it must represent an important component in the evolutionary legacy of the biological species. The first criterion, reproductive isolation, need not be absolute but must have been strong enough to permit evolutionarily important differences to occur in different population units. The second criterion is met if the population contributes substantially to the ecological or genetic diversity of the species as a whole.
- **Fallback** Adult fish that successfully pass upstream of a dam, but are either swept or swim through the

- spillway, turbines, or navigation locks to below the dam.
- **FERC License** A Federal license for hydroelectric projects that includes requirements and restrictions about how the projects are maintained and operated. The PUD hydroelectric projects are licensed by FERC under the Federal Power Act.
- **First Year Value** First year value is the cost and foregone power revenues incurred in the first year of the 50-year analysis period.
- **Fishladder** A series of ascending pools constructed to enable salmon or other fish to swim upstream to pass a barrier.
- **Fish Passage Efficiency** The portion of all juvenile salmon and steelhead passing a facility that do not pass through the turbines.
- **Fish Passage Facilities** The features of a dam that enable fish to move around, through, or over a dam without harm. Facilities generally include an upstream fishladder and/or a downstream bypass system. See also *Fishladder* and *Bypass System*.
- Flow (or Discharge) A measurable quantity of water passing through a dam or a reach of river over a given period of time. Flows for rivers in the United States are commonly reported in cubic feet per second (cfs).
- **Fluvial** Related to rivers or produced by river action, as a fluvial plain or river bar.
- **Forebay** The portion of the reservoir at a hydroelectric plant which is immediately upstream of the generating station.
- **Fry** Life stage of fish between the egg and fingerling stages. For salmon this typically refers to fish less then 50 millimeters long.
- Gas Bubble Disease Condition caused when dissolved gas in supersaturated water comes out of solution and equilibrates with atmospheric conditions, forming bubbles within the tissue of aquatic organisms. Gas bubble disease is also known as gas bubble trauma or GBT.

- Gas Supersaturation Concentrations of dissolved gas in water that are above the saturation (100 percent capacity) level of the water.
- **Geomorphology** Branch of geology that deals with the form of the earth and earth surface and the changes that take place in river and hillside landforms.
- **Glacial** Related to or formed by a glacier. Extensive glaciers flowed into the Mid-Columbia River area, greatly influencing the river and valley landforms and geologic deposits.
- **Gneiss** Coarse-grained, metamorphic rock in which bands of differing mineral composition and texture appear.
- **Graben** An elongate, trench-like structural form bounded by parallel faults, created when the block that forms the valley floor moved downward relative to the blocks that form the valley wall sides.
- Habitat The location where a particular taxon of plant or animal lives and its surroundings; the term includes the presence of a group of particular environmental conditions surrounding an organism including air, water, soil, mineral elements, moisture, temperature, and topography.
- Habitat Conservation Plan (HCP) Under Section 10 (a)(2)(A) of the Endangered Species Act, a planning document that is a mandatory component of an incidental take permit application. The HCP process is intended to provide a comprehensive, long-term management plan to protect and facilitate the recovery of threatened and endangered species, and to provide a framework for "creative partnerships" between the public and private sectors in endangered species conservation (H.R. Rep. No. 97-835, 97th Congress, Second Session).
- **Habitat Improvement** Management of wildlife or fish habitat to increase its capability for supporting wildlife or fish.
- Harass Defined in regulations implementing the Endangered Species Act promulgated by the Department of the Interior as "an intentional or

- negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, and sheltering" (50 CFR17.3). NMFS has not defined "harass" by regulation.
- Harm Defined in regulations implementing the Endangered Species Act promulgated by the Departments of Interior and Commerce as an act "which actually kills or injures" listed fish or wildlife; harm may include "significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering" (50 CFR 17.3 and 50 CFR 222.102).
- **Hatchery** A facility in which fish eggs are incubated and hatched and juvenile fish are reared for release to rivers or lakes.
- **Headwater Elevation** The average or maximum reservoir elevation at the project dam.
- **Historic Integrity** The extent to which a property has retained its original design and setting.
- **Historic Property** A property listed on the National Register of Historic Places.
- **Hydroelectric** Referring to the production of electric power through use of the gravitational force of falling water.
- **Hydrology** The science of the continuous cycle of evapotranspiration, precipitation, and run-off.
- Incidental Take Take of any Federally listed fish, wildlife, or plant species that is incidental to, but not the purpose of, otherwise lawful activities. See definition for *take* [Endangered Species Act Section 10(a)(1)(B)].
- Incidental Take Permit A permit that exempts a permittee from the take prohibition of Section 9 of the Endangered Species Act, provided that a conservation plan has been developed that specifies the likely take and steps that the

applicant will use to mitigate and minimize the take. An incidental take permit is issued by USFWS or NMFS under Section 10 of the Endangered Species Act for non-Federal applicants.

- Incidental Take Statement An incidental take statement is issued under Section 7 of the Endangered Species Act for projects that involve a Federal action. The statement identifies the extent of the take that would occur as a result of the action, as well as reasonable and prudent measures to minimize the take.
- **Instream Flow** The amount of water in a river or creek required to sustain fisheries and water quality needs.
- **Intake** The entrance to a conduit through a dam or water facility.
- **Juvenile** The early stage in the life cycle of anadromous fish when they migrate downstream.
- **Juvenile Bypass** Facility that is used to collect, divert or guide juvenile fish around a dam that provides a safer passage route than through the turbine units. See also *Bypass System*.
- **Kelts** Adult steelhead that have completed spawning and are returning to the ocean. Steelhead can spawn more than once in their lifetime.
- **Levelized Value** A constant stream of values, using a given interest rate, that produces the same net present value as the non-constant stream of values (if future values change over time).
- Listed Species Wildlife, fish, or plants that are identified as either threatened or endangered within a region, state, or nation. Federally listed species are listed by USFWS or NMFS and consequently receive statutory protection throughout areas where their populations are in decline under the Endangered Species Act.
- **Measures** Any action, structure, facility, or program (on-site or off-site) intended to improve the survival of Plan species.

- Mid-Columbia River When used in reference to a geographic area, it means that portion of the Columbia River that begins at its confluence with the Yakima River up to the Chief Joseph Dam. It may also be used to reference the Mid-Columbia River Evolutionarily Significant Unit. See also Upper Columbia River and Mid-Columbia River Steelhead Evolutionarily Significant Unit.
- Mid-Columbia River Steelhead Evolutionarily
 Significant Unit The ESU includes all naturally spawned populations of steelhead in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington.
 Excluded are steelhead from the Snake River Basin.
- Mitigation Measures designed to counteract environmental impacts or make impacts less severe. These measures may include amending an impact by not taking a certain action or part of an action; minimizing an impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; or compensating for the impact by replacing or providing substitute resources or environment.
- Monitoring HCP monitoring consists of two types:

 (1) compliance monitoring, in which NMFS monitors the permittee's implementation of the requirements of the HCP, incidental take permit terms and conditions and implementation agreement, if applicable; and (2) effects and effectiveness monitoring, in which the permittee (or other designated entity) examines the impacts of the authorized incidental take (effects) and implementation of the operating conservation program to determine if the actions are producing the desired results (effectiveness).

National Environmental Policy Act (NEPA) –

Federal legislation establishing national policy that environmental impacts will be evaluated as an integral part of any major Federal actions significantly affecting the quality of the human environment (42 USC §§ 4321-4327).

- National Register of Historic Places The official Federal list of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, engineering, and culture.
- **Net Present Value** Discounted value today of the future values using a given discount rate.
- No Net Impact The objective of the HCPs is to achieve 100 percent no net impact for each Plan species affected by the Wells, Rocky Reach, and Rock Island hydroelectric projects. The no net impact standard consists of two primary components: 91 percent combined juvenile and adult project passage survival achieved by project improvement measures implemented within the geographic area of the projects, and a 9 percent compensation for unavoidable project mortality. The utilities would compensate for the 9 percent fish loss at the projects through a hatchery and tributary habitat fund. Hatcheries would compensate for 7 percent of fish mortality at the projects. Habitat improvements in the Mid-Columbia River tributaries would compensate for the remaining 2 percent mortality. This compensation for project mortality would result in a no net impact standard at the three projects.
- No Surprises Policy A policy of NMFS and USFWS providing regulation assurances for an HCP incidental take permit holder that no additional land use restrictions or financial compensation would be required with respect to species covered by the permit, even if unforeseen circumstances arise after the permit is issued that indicate additional mitigation is needed to protect the species.
- Noxious Weeds These weeds are non-native plants that have been introduced to Washington.

 Noxious weeds can be destructive and competitive with native plants, and difficult to control by cultural or chemical practices. These exotic species can reduce crop yields, replace native plant and animal habitat, affect land values and recreational opportunities, and infiltrate waterways.
- **Old-Growth Forest** A forest stand characterized by trees well past the age of maturity (dominant trees

- exceed 200 years of age). Stands exhibit declining growth rates and signs of decadence, such as dead and dying trees, snags, and downed woody material.
- **Performance criteria** Standards used to determine the adequacy of the mitigation and conservation measures implemented to protect the species.
- Permit An incidental take permit issued to the PUD pursuant to Section 10(a)(1)(B) of the Endangered Species Act to authorize any incidental take of listed species which may result from the PUD's otherwise lawful operation of the project, conducted in accordance with this agreement.
- Permit species For the purposes of this EIS, Permit species are all Plan species except coho salmon (*Oncorhynchus kisutch*). Permit species do not include coho salmon since wild coho salmon are extirpated from the Mid-Columbia region and therefore not protected by the Endangered Species Act.
- **Physiographic Regions** Areas with similar landforms, geologic materials, soils, and climate.
- PIT-Tag A Passive Integrated Transponder tag
 (about the size of a grain of rice) transmits a
 digital code, unique to an individual fish, when the
 tagged animal passes through a detection tunnel.
 The tag uses the power emitted by the detection
 system to transmit the signal, thus it has no
 batteries (making it functional for years). The tag
 is typically used on juvenile fish to assess passage
 survival, as well as to track adult passage rates.
- **Plan Species** For the purposes of this EIS, Plan species are spring-run and summer/fall-run chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*O. nerka*), coho salmon (*O. kisutch*), and steelhead (*O. mykiss*).
- **Powerhouse** Section of a dam that contains the turbine units to generate electricity.
- Priority Habitats (as designated by WDFW) –
 Priority habitats are those habitat types or
 elements with unique or significant value to a
 diverse assemblage of species. A priority habitat
 may consist of a unique vegetation type or

dominant plant species, a described successional stage, or a specific structural element.

Project – (1) Refers to the Anadromous Fish Agreements and Habitat Conservation Plans Environmental Impact Statement for the Wells, Rocky Reach, and Rock Island hydroelectric projects, or (2) refers to an individual hydroelectric project (reservoir, forebay, dam, and tailrace).

Proposed Action – Under NEPA regulations, a plan that has a goal which contains sufficient details about the intended actions to be taken or that will result, to allow alternatives to be developed and its environmental impacts to be analyzed (40 CFR 1508.23).

Proposed Species – A species for which a proposed rule to add the species to the Federal list of threatened and endangered species has been published in the Federal Register.

Quantitative Analysis Report (QAR) – The Upper Columbia QAR process was established to provide decision makers with current assessments of the status of Endangered Species Act-listed spring-run chinook salmon and steelhead runs returning to the Upper Columbia River. Simple population models were developed for Upper Columbia River spring-run chinook salmon (Wenatchee, Entiat, and Methow populations) and summer steelhead (Wenatchee/Entiat and Methow populations). The models are based on reconstructed spawner to spawner return ratios for historical years. Alternative assumptions regarding the effectiveness of hatchery-origin spawners are considered in the analysis for steelhead, and a range of future environmental conditions were analyzed for spring-run chinook. A range of alternative future survival improvements for Upper Columbia River stocks were modeled, including an analysis of the expected survival improvements that could be expected from implementation of the long-term mitigation measures outlined in the Chelan and Douglas County PUD HCPs.

Radio-telemetry – Methodology consisting of attaching or implanting a radio tag in a fish or animal to track its movements or to detect its

presence in specific areas that are monitored with a radio receiver and antenna.

Record of Decision (ROD) – Under NEPA regulations, a concise public record of decision prepared by the Federal agency, pursuant to NEPA, that contains a statement of the decision, identification and discussion of all factors used by the agency in making its decision, identification of all alternatives considered, identification of the environmentally preferred alternative, a statement as to whether all practical means to avoid or minimize environmental harm from the alternative selected have been adopted (and if not, why they were not), and a summary of monitoring and enforcement measures, where applicable, for any mitigation (40 CFR 1505.2).

Redd – Depression in river or lake bed dug by fish for the deposition of eggs (spawning nests).

Reservoir – An artificially impounded body of water.

Resident – Describes the life-history characteristic of a fish species that spends its entire life in freshwater.

Riparian Vegetation – Riparian zones are broadly defined as those non-aquatic areas contiguous with waterbodies (wetlands, lakes, streams, and rivers) that are influenced by, and which influence, that waterbody. Often riparian zones exhibit higher plant and animal diversity and productivity than surrounding uplands, and are particularly important to fish and wildlife in arid regions. Riparian vegetation may or may not be distinct from the adjacent upland vegetation.

Rip-rap – Broken rock, cobbles, or boulders placed on the bank of a stream or river for protection against the erosive action of water.

River Terrace – Relatively flat areas formed by the rivers. Terraces near the rivers are active floodplains; higher terraces have been abandoned by river downcutting and are no longer accessed by flood flows. Floodplain terraces are common locations for wetlands and side channels, and are important areas for storage of floodwaters and aquatic and wildlife habitat.

- Run-of-the-River Hydroelectric Project The Wells, Rocky Reach, and Rock Island hydroelectric projects are run-of-the river projects, which means that they do not store substantial amounts of water in their reservoirs. Run-of-the-river hydroelectric projects produce electric power through use of the gravitational force of falling water, and consist of a powerhouse, spillway, and embankments, as well as fish passage facilities.
- **Salmonids** Fish of the family Salmonidae, such as salmon, trout (including steelhead), char, and whitefish.
- **Schist** Medium- or coarse-grained, metamorphic rock dominated by subparallel orientation of platy mica minerals.
- Scoping The process of defining the scope of a study, primarily with respect to the issues, geographic area, and alternatives to be considered. The term is typically used in association with environmental documents prepared under NEPA.
- Section 10 The section of the Endangered Species Act dealing with exceptions to the prohibitions of Section 9 of the Endangered Species Act.
- Section 10(a)(1)(A) That portion of Section 10 of the Endangered Species Act that allows for permits for the taking of threatened or endangered species for scientific purposes or for purposes of enhancement of propagation or survival.
- Section 10(a)(1)(B) That portion of Section 10 of the Endangered Species Act that allows for permits for incidental taking of threatened or endangered species.
- **Section 10(a)(2)(A)** That portion of Section 10 of the Endangered Species Act that identifies the requirements of a habitat conservation plan.
- Section 10(a)(2)(B) That portion of Section 10 of the Endangered Species Act that identifies the findings that must be made in order to issue an incidental take permit based upon the habitat conservation plan.
- **Section 106 of the Historic Preservation Act** A Federal regulation that requires properties with

- Federal involvement to take into consideration impacts to properties listed in or eligible for the National Register.
- **Section 4(d)** Section of the Endangered Species Act that allows NMFS or USFWS to adopt whatever protective regulations it deems necessary for the conservation of a threatened species. This section does not apply to endangered species.
- **Section 7** The section of the Endangered Species Act which describes the responsibilities of Federal agencies in conserving threatened and endangered species. Section 7(a)(1) requires all Federal agencies "in consultation with and with the assistance of the Secretary [to] utilize their authorities in the furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species." Section 7(a)(2) requires Federal agencies to "ensure that any action authorized, funded, or carried out by such agency...is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of..." designated critical habitat.
- **Section 9** The section of the Endangered Species Act dealing with prohibited acts, including the take of any listed species without the specific authorization of USFWS or NMFS for species under the jurisdiction of each agency.
- **Sediment** Clay, silt, sand, gravel, and cobbles that are deposited into layers by wind, ice, water, or gravity.
- Settlement Agreement An agreement that settles a legal dispute. In the context of this EIS, relevant settlement agreements are the 1990 Wells Long-Term Settlement Agreement, the 1994 Fourth Revised Rocky Reach Interim Stipulation (expired), the 1987 Rock Island Settlement Agreement, and the Vernita Bar Agreement. In addition, the Wells, Rocky Reach, and Rock Island HCPs are also settlement agreements that are expected to supercede all of the above agreements, except for the Vernita Bar Agreement.

- Signatory Parties For the purposes of this EIS, signatory parties refers to those agencies, tribes, and non-governmental organizations that will ultimately sign and abide by the terms of the HCPs. As a result, each of the signatory parties will be represented on the HCP committees.
- **Sluice** A spill gate specifically designed to drain water from the surface of the reservoir.
- **Smolt** A juvenile salmon or steelhead migrating to the ocean and undergoing physiological changes to adapt its body from a freshwater to a saltwater environment.
- **Spawning** The releasing and fertilizing of eggs by fish.
- **Species** –any subspecies of fish or wildlife or plants and any distinct population segment of any species of vertebrate fish or wildlife that interbreeds when mature.
- **Spill** Water passed over a spillway instead of going through turbines to produce electricity. Spill can be forced when there is no storage capacity and flows exceed turbine capacity, or it can be planned, for example, when water is spilled to enhance juvenile fish passage.
- **Spillway** The overflow structure of a dam.
- State Environmental Policy Act (SEPA) Chapter 43.21C RCW. Enacted in 1971, it provides the framework for agencies to consider the environmental consequences of a proposal before taking action. It also gives agencies the ability to condition or deny a proposal due to identified likely significant impacts. The Act is implemented though the SEPA Rules, Chapter 197-11 WAC.
- Steering Committee Group or panel of individuals representing affected interests or stakeholders in a conservation planning program, the private sector, and the interested public, which may be formed by the appropriate development, land use, and mitigation strategies, and to communicate progress to their larger constituencies. USFWS and NMFS representatives may participate to

- provide information on procedures, statutory requirements, and other technical information.
- Storage Reservoir A reservoir that has space for retaining water from springtime snowmelts. Retained water is released as necessary for multiple uses—power production, fish passage, irrigation, and navigation.
- **Structural Depression** Valley area formed by geologic faulting.
- **Subyearlings** Juvenile fish less than 1 year old.
- **Tailrace** The canal or channel that carries water away from a dam.
- **Tailwater Elevation** The average or minimum water elevation at the toe of the dam.
- Take Under Section 3(18) of the Endangered Species Act, "...to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct" with respect to Federally listed endangered species of wildlife. Federal regulations provide the same taking prohibitions for threatened wildlife species [50 CFR 17.31(a)].
- Threatened Species Any species designated under the Endangered Species Act that "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" [Section 3(19) of the Endangered Species Act].
- **Tool** For the purposes of this EIS, tool means any action, structure, facility or program (on-site only) at the Wells, Rocky Reach, and Rock Island dams that are intended to improve the survival of Plan species migrating through the dams. Tools do not include fish transportation, drawdowns, dam removal, and non-power operations.
- **Total Dissolved Gas** Total dissolved gas is the amount of all gases that are in solution (e.g., nitrogen, carbon dioxide, oxygen).
- **Tributaries** Smaller streams or rivers that enter larger water bodies. For example, the Wenatchee

River is a tributary of the Columbia River and Icicle Creek is a tributary of the Wenatchee River.

Turbidity – A measure of the cloudiness or opaqueness of water. In other words, muddy water has high turbidity and clear water has low turbidity. Turbidity is measured by an instrument that passes a beam of light through a water sample and measures the degree to which the light is scattered by suspended particles.

Turbine – Machinery that converts kinetic energy of a moving fluid, such as falling water, to mechanical or electrical power.

Upper Columbia River – When used in reference to a geographic area, it means that portion of the Columbia River upstream of Chief Joseph Dam. It may also be used to reference the Upper Columbia River Evolutionarily Significant Unit. See also Upper Columbia River Spring-Run Chinook Salmon Evolutionarily Significant Unit and Mid-Columbia River.

Upper Columbia River Spring-Run Chinook
Salmon Evolutionarily Significant Unit – This
Evolutionarily Significant Unit contains the only
remaining genetic resources of those spring-run
chinook salmon that migrated into the Upper
Columbia River basin (prior to the construction of
Grand Coulee Dam), as well as those spring-run
chinook salmon that historically migrated to the
Mid-Columbia River region. NMFS also
identified six hatchery stocks associated with the
Upper Columbia River spring-run Evolutionarily
Significant Unit: Chiwawa River, Methow River,

White River, Twisp River, Chewuch River, and Nason Creek.

Water Quality Standards – Define the minimum requirements to protect beneficial uses of rivers, creeks, lakes, and other waterbodies and are required by the Federal Clean Water Act for all states to establish and enforce. The current Water **Ouality Standards for Surface Waters of the State** of Washington (Chapter 173-201A of the Washington Administrative Code) designate water bodies as "Class AA" (extraordinary), "Class A" (excellent), or other classes. Each class has numerical and narrative standards to protect general beneficial uses, with Class AA having the most stringent standards. In the future the standards will be changed to identify specific beneficial uses for each waterbody. Similar to State standards, Tribes administer water quality standards on their lands.

Water Rights – Water rights permits are required from WDOE to withdraw water from rivers, creeks, and lakes, and may be required for groundwater resources. These permits specify where, when, and how much water may be withdrawn.

Wetlands – Areas that are inundated by surface water or groundwater frequently enough to support vegetation that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include marshes, bogs, peatlands, and similar areas such as river overflows, mudflats, and natural ponds.

Distribution List

CHANGES MADE BETWEEN THE DEIS AND FEIS FOR CHAPTER 8

•	The mailing list was revised, updated, and now includes addresses for all individuals and
	organizations who provided comment letters on the DEIS.

DISTRIBUTION LIST

FEDERAL AGENCIES

Bonneville Power Administration (BPA)

Bureau of Indian Affairs (BIA)

Bureau of Land Management (BLM)

Council on Environmental Quality (CEQ)

Federal Energy Regulatory Commission (FERC)

National Marine Fisheries Service (NMFS)

National Oceanic and Atmospheric Administration (NOAA)

Mt. Baker-Snoqualmie National Forest

North Cascades National Park

Office of the Solicitor (USFWS)

Office of General Council, USDA (Forest Service)

Okanogan National Forest

Rural Utilities Service (RUS)

U.S. Army Corps of Engineers – Portland, Walla Walla, and Seattle Districts

U.S. Department of Agriculture (USDA)

U.S. Department of Commerce (DOC)

U.S. Department of Energy (DOE)

U.S. Department of the Interior (DOI)

U.S. Environmental Protection Agency (EPA)

U.S. Fish and Wildlife Service (USFWS)

U.S. Representatives, State of Washington

U.S. Senate, Chief of Staff

U.S. Senators, State of Washington

Wenatchee National Forest

STATE AGENCIES/ELECTED OFFICIALS

Alaska State Department of Fish and Wildlife

Governor, State of Washington

Governor's Salmon Recovery Office

Lieutenant Governor, State of Washington

Oregon State Department of Fish and Wildlife

Oregon Department of Justice

Washington Environmental Council

Washington State Attorney General's Office

Washington State Assistant Attorney General

Washington State Commissioner of Public Lands

Washington State Department of Ecology

Washington State Department of Fish and Wildlife

Washington State Department of Health

Washington State Department of Natural Resources

Washington State House of Representatives,

Standing Committees -

Agriculture & Ecology

Environment, Energy & Water Committee

Natural Resources

Rules

Technology, Telecommunications & Energy

Speaker, Washington State House of

Representatives

Majority Leader, Washington State House of

Representatives

Minority Leader, Washington State House of

Representatives

Washington State Representatives, 4th District Washington State Representatives, 7th District

Washington State Representatives, 10th District

Washington State Representatives, 12th District

Washington State Representatives, 13th District

Washington State Representatives, 15th District

Washington State Representatives, 16th District

Washington State Representatives, 18th District

Washington State Representatives, 19th District

Washington State Representatives, 20th District

Washington State Representatives, 24th District

Washington State Representatives, 27th District

Washington State Representatives, 32nd District

Washington State Representatives, 34th District

Washington State Representatives, 35th District

Washington State Representatives, 44th District

Washington State Senate, Standing Committees –

Agriculture & International Trade Environment, Energy & Water

Natural Resources, Parks & Shorelines

Rules

Ways & Means

Majority Leader, Washington State Senate Minority Leader, Washington State Senate Washington State Senator, 3rd District Washington State Senator, 5th District

Washington State Senator, 7th District Washington State Senator, 11th District Washington State Senator, 12th District Washington State Senator, 16th District Washington State Senator, 20th District Washington State Senator, 20th District Washington State Senator, 24th District Washington State Senator, 26th District Washington State Senator, 31st District Washington State Senator, 39th District Washington State Senator, 40th District Washington State Senator, 45th District Washington State Senator, 46th District Washington State Senator, 46th District Washington State Senator, 48th District Washington State Senator, 48th District

LOCAL AGENCIES AND SCHOOLS

Cashmere School District No. 22

Chelan County Commissioners
Douglas County Commissioners

Douglas County Courthouse Entiat School District No. 127

Malaga/Colockum Community Council

Mayor, City of Brewster Mayor, City of Bridgeport Mayor, City of Cashmere Mayor, City of Chelan

Mayor, City of East Wenatchee

Mayor, City of Entiat

Mayor, City of Leavenworth

Mayor, City of Pateros

Mayor, City of Rock Island Mayor, City of Wenatchee

Mayor, Town of Mansfield

Mayor, Town of Waterville

North Central Educational Service District

Port of Douglas County

Wenatchee Valley Chamber of Commerce

Wenatchee Valley College

NATIVE AMERICAN ORGANIZATIONS

Burns Paiute Tribe

Coeur d'Alene Tribe

Columbia River Inter-Tribal Fish Commission Confederated Tribes and Bands of the Colville

Reservation

Confederated Tribes and Bands of the Yakama

Indian Nation

Confederated Tribes of the Umatilla Indian

Reservation

Confederated Salish and Kootenai Tribes of Flathead Reservation

Confederated Tribes of the Warm Springs Reservation

Kalispel Tribe

Kootenai Tribe of Idaho

Nez Perce Tribe

Northwest Indian Fisheries Commission

Shoshone-Bannock Tribe of Fort Hall

Shoshone-Paiute Tribe of Duck Valley Reservation

Spokane Tribe of Indians

UTILITIES

Avista Corporation

Public Utility District No. 1 of Chelan County

Public Utility District No. 1 of Douglas County

Public Utility District No. 2 of Grant County

Idaho Power Council

Public Utility District No. 1 of Okanogan County

Puget Sound Energy

Portland General Electric

PacifiCorp

Wenatchee Reclamation District

ORGANIZATIONS

American Lands Alliance

American Public Power Association (APPA)

American Rivers

American Rivers, NW Office Chelan County Pomona No 23

Chelan-Douglas County Land Trust

Friends of the Wild Swan

Greater Wenatchee Community Foundation

Icicle Creek Watershed Council National Audubon Society

Northwest Power Planning Council (NWPPC)

National Wildlife Federation

Nature Conservancy of Washington Okanogan Wilderness League Peshastin Hi-Up Growers Pacific Northwest Generating Cooperative (PNGC)
Pacific Northwest Utilities Conference Committee

(PNUCC)

Public Power Council (PPC)
Quest for Economic Development
Rivers Council of Washington
Save Our Wild Salmon

Sierra Club

Sierra Club Legal Defense Fund

Trout Unlimited

Washington Growers Clearing House Assn.

Washington PUD Association

Washington Trout

Wenatchee Downtown Association

BUSINESSES

ALCOA

American Silicon Technologies

Cashmere Valley Bank

Central Washington Hospital Cockrill & Weaver, P.S.

Colockum Transmission Company

D. Rohr and Associates Davis, Wright & Tremaine Development Partners, LLC Dick Nason Consulting Inc

Duke Engineering Erlandsen & Assoc.

Foreman Arch Dodge Volyn & Zimmerman

Gordon, Thomas & Honeywell Historical Research Associates, Inc. Hobbs, Straus, Dean & Walker, LLP Jeffers, Danielson, Sonn & Aylward, P.S

Law Offices of Tim Weaver Litchfield Consulting Group Mann & Gellatly Marson & Marson Northwestern University

Ogden Environmental and Energy Pacific Aerospace & Electronics, Inc

Paine Hamblen
Parametrix, Inc.
Perkins Coie
Stamilt Crowners

Stemilt Growers, Inc Steptoe & Johnson Thompson Ass

Thomas H. Nelson Law Offices

Triangle Associates, Inc. Troutman Sanders Van Ness Feldman, P.C.

Vanderstoep, Remund & Kelly Wenatchee Valley Clinic Weyerhaeuser Company

MEDIA

Associated Press

KHQ Television (Spokane) Douglas County Empire Press KIMA Television (Yakima) KING Television (Seattle) KIRO Television (Seattle) KOMO Television (Seattle) KOZI Radio (Chelan) KPQ Radio (Wenatchee) KREM Television (Spokane) KXLY Television (Spokane)
PR Newswire
Seattle Post-Intelligencer
The News Tribune
The Columbian
The Herald

The Oregonian
The Seattle Times
The Spokesman-Review
Tri-City Herald
Wenatchee World
Yakima Herald-Republic

LIBRARIES

Brewster Community Library
Chelan Community Library
Colville Tribal Libraries/Resource Center
Entiat Community Library
Leavenworth Community Library
Multnomah County Library, Central Library
Okanogan Community Library
Oregon State Library
Stream Net Library - Columbia River Inter-Tribal
Fish Commission

Twisp Community Library
Umatilla County Special Library District
Washington State Library
Wenatchee Public Library
Winthrop Community Library
Yakima Nation Library
Yakima Valley Regional Library

List of Preparers

CHANGES MADE BETWEEN THE DEIS AND FEIS FOR CHAPTER 9

•	Additional	FEIS	project	staff	were	added.
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9 LIST OF PREPARERS

The Anadromous Fish Agreements and Habitat Conservation Plans FEIS for the Wells, Rocky Reach, and Rock Island Hydroelectric Projects was prepared by a team of specialists from a wide range of disciplines. The primary team members are listed below.

Name	BACKGROUND	EXPERIENCE	
Ritchie Graves	M.A., Zoology, University of Montana	Experience includes 4 years as a project	
Lead Biologist	B.S. Biology, Centre College of Kentucky	biologist for the Smolt Monitoring Program at	
National Marine Fisheries Service, Portland, Oregon	B.S. English, Centre College of Kentucky	John Day Dam on the Lower Columbia River followed by 5 years of experience evaluating and addressing the effects of mainstem	
	National Marine Fisheries Service – 9 years	Federal and non-Federal hydroelectric project on the Columbia and Snake rivers.	
	Montana Department of Fish, Wildlife and Parks - < 1 year	on the columbia and chake fivers.	
Pam Gunther	M.A., Biology, California State University	Experience includes more than 18 years in the	
Project Manager	B.S., Wildlife (Forest Resources), University of	organization and oversight of environmental impact statements, with expertise in long-rang	
Parametrix, Inc., Kirkland, Washington	Washington	planning and management of natural and biological resources.	
	Parametrix – 10 years		
	U.S. Forest Service – 7 years		
	Ebasco Environmental – 2 years		
	EA Engineering – 2 years		
Bob Sullivan	B.S., Fisheries, University of Washington	Nineteen years of consulting and research experience on fish habitat assessment and enhancement projects, which includes work	
Fisheries Task Leader			
Parametrix, Inc., Kirkland,	Parametrix – 16 years	evaluating bypass options, total dissolved gas	
Washington	Quinault Indian Nation – 5 years	levels, and methods to reduce total dissolved gas at Mid-Columbia hydroelectric projects.	
Jim Good	M.S., Aquatic Ecology, University of Idaho	Experience includes 13 years working with	
Water Resources Task Leader	B.S., Forest Management, University of Missouri	water quantity and quality and sediment issues and pertinent regulations. Other related experience includes hydrology and fish habitat	
Parametrix, Inc., Kirkland, Washington	Parametrix – 14 years	assessments in National Forests with Idaho, Washington, Oregon, and Alaska.	
Gary Maynard, AICP Land Use Task Leader	M.A. Candidate, Geography, University of Washington	Experience includes 13 years in land use, energy, natural resources, public services, an noise evaluations, analysis, and management	
Parametrix, Inc., Kirkland,	B.A., Geography, University of Washington		
Washington	Parametrix – 13 years		
	City of Bellevue – 3 years		

Name	BACKGROUND	EXPERIENCE	
Marcia Montgomery Cultural Resources Task Leader	M.A., History, Washington State University B.A., History, Lewis and Clark College	Experience includes 7 years of experience conducting cultural resource assessments of historic buildings, structures, and	
Historical Research Associates, Seattle, Washington	Historical Research Associates – 3 years BOAS, Inc – 2 years	archaeological sites and addressing cultural resources according to Section 106 of the Historic Preservation Act, NEPA.	
Tradimigran	National Park Service- 1 year		
	U.S. Forest Service – 1 year		
Clay Antieau	Ph.D. Candidate, Horticulture and Botany,	Experience includes more than 14 years as a	
Plants Task Leader	University of Washington	botanist in western Washington specializing in identification and ecology of Pacific Northwest	
Parametrix, Inc., Kirkland, Washington	M.S., Horticulture and Botany, University of Washington	native plants and their habitats. Work includes conducting rare plant and wildlife surveys at	
3	B.S., Horticulture, Purdue University	hydroelectric projects.	
	Parametrix – 3 years		
	Gaynor Landscape Architects – 3 years		
	Foster Wheeler – 5 years		
	WSU Cooperative Extension – 2 years		
David Mattern, AICP	M.A., Geography, University of Colorado	Experience includes more than 16 years in	
Socioeconomics and Recreation Task Leader	B.S., Geography, University of Washington	environmental planning with responsibilities in EIS recreation analysis, planning policy evaluations, and land use, visual quality, and	
Parametrix, Inc., Kirkland, Washington	Parametrix – 18 years	public service assessments. Work includes research and reports on land use, visual quality, and recreation for hydroelectric projects.	
Julie Grialou	M.S., Wildlife Science, University of	Experience includes more than 7 years of work	
Wildlife Task Leader	Washington	with threatened and endangered wildlife species, habitat evaluations, populations	
Parametrix, Inc., Kirkland, Washington	B.A., Anthropology, Harvard University	studies, vegetation surveys, and preparation of associated reports.	
	Parametrix – 4 years	·	
	Pacific Forest Trust – 2 years		
	Bureau of Land Management – 2 years		
Bruce Stoker	M.S.E., Civil Engineering, University of	Experience includes 19 years in geologic	
Geology Task Leader	Washington	mapping, sediment transport studies, erosion control plans, hydrologic investigations,	
Earth Systems, Monroe, Washington	M.S., Remote Sensing/Geology, University of Michigan	engineering review, licensing and permitting, and compliance with regulations related to	
	B.S., Geology, Michigan State University	project design.	
	Earth Systems – 6 years		
	Ebasco Environmental – 9 years		
	U.S. Forest Service – 1 year		

NAME	Background	Experience	
Jill Czarnecki	B.S., Geology, University of Puget Sound	Experience includes 2 years in the organization	
Project Assistant		and preparation of environmental impact statements.	
Parametrix, Inc., Kirkland, Washington	Parametrix – 2 years	statements.	
Becky Reininger	M.A., Geography, University of Washington	Experience includes 10 years in the	
Aesthetics Task Leader Project Assistant	B.A., Environmental Planning, Huxley College at Western Washington University	organization and preparation of environmental documents including EAs, EISs, and FERC License applications.	
Parametrix, Inc., Kirkland, Washington	Parametrix – 2 years Pacific International Engineering – 2 years Harza NW/Hosey & Associates – 6 years		
Daryl Wendle	M.A., English, New York University	Experience includes 12 years preparing	
Senior Planner	B.A., English, University of Oregon	regional transportation planning and environmental impact studies.	
Parametrix, Inc., Kirkland,		environmental impact studies.	
Washington	Parametrix – 4 years		
	DKS Associates – 3 years		
	KJS Associates – 3 years		
	Beak, Inc. – 2 years		
Linda Goetz	Anthropology Graduate Program (1990-1993),	Experience includes 9 years in archaeologic	
Cultural Resource Specialist Historical Research Associates, Seattle, Washington	University of Washington	survey, excavation, and analysis. Other related work includes conducting background	
	B.A., Anthropology, Northwestern University	research, mapping, processing and catalogi archaeological materials, conducting Indian	
	Historical Research Associates – 7 years	consultation, and writing and editing	
	Dames and Moore – 1 year	professional reports.	
Lorena Dinger	Technical Editing Certification Program,	Experience includes over 5 years of technical	
Technical Editor	Bellevue Community College	writing and editing experience, 2 years of which focused on preparation of NEPA environmental	
Parametrix, Inc., Kirkland,	Parametrix – 2 years	assessments and environmental impact	
Washington	Freelance writer/editor – 3 years	statements and other environmental documents.	

Chapter 10 Index

For report sections, see under "R".

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