
ROCKY REACH PACIFIC LAMPREY MANAGEMENT PLAN

Final Draft

ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145

September 6²³, 2005



Public Utility District No. 1 of Chelan County
Wenatchee, Washington

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EXECUTIVE SUMMARY

Little specific information is currently known about the life history or status of Pacific lamprey in the vicinity of the Rocky Reach Hydroelectric Project (Project). Pacific lamprey are known to occur in the Wenatchee, Entiat, and Methow rivers, and they migrate through the mainstem Columbia River. Adult passage has been documented at the fishways of the Rocky Reach and Rock Island dams. It is unknown whether lamprey use the mainstem Columbia River for spawning.

Research at other mainstem dams has identified areas within adult fishways that are problematic for lamprey passage. In 2004, during the relicensing process, the Natural Resources Working Group (NRWG) determined that Chelan PUD should conduct a study at the Project to evaluate passage of adult Pacific lamprey through the upstream fishway, and to document any downstream passage from the upstream fishway. The purpose of the study was to identify potential upstream passage impediments in the Rocky Reach Dam's fishway in order to address the goal of the Pacific Lamprey Management Plan (PLMP) stated below. Details of the study are located in ~~section~~ [Section 3](#) of this plan.

The goal of the PLMP is to identify any negative impacts on Pacific lamprey from ongoing Project operations and fishways, and to develop Protection, Mitigation, and Enhancement measures (PMEs) to reduce or eliminate those impacts, in consultation with the Rocky Reach Fish Forum (RRFF). Objectives to achieve this goal include addressing 1) potential ongoing Project-related impacts on upstream passage of adult Pacific lamprey; 2) potential ongoing Project-related impacts on downstream passage of juvenile Pacific lamprey; 3) potential ongoing Project-related impacts on the existing reservoir habitat used currently by juvenile Pacific lamprey; 4) identifying and implementing ~~on-site or~~ off-site measures to address unavoidable impacts to achieve No Net Impact (NNI); and 5) provide funding for regional research to support objectives 1 through 4.

The PLMP uses adaptive management,¹ allowing for the adjustment of goals and objectives through a collaborative process, based on new information and ongoing monitoring results. Accordingly, the PLMP will be reviewed on a periodic basis by the RRFF to allow for planning and future adjustments over the term of the New License. In addition, the PLMP is intended to be consistent with other Pacific lamprey management plans in the mid-Columbia region.

The PLMP calls for Chelan PUD to implement the following PMEs described in ~~section~~ [Section 4](#):

1. Continue to provide upstream and downstream passage for Pacific lamprey through the Project's upstream fishway and downstream bypass, in accordance with the operation criteria for anadromous salmonids and compatible bull trout migration guidelines;

¹ Definition of "Adaptive Management" TBD by Bob Rose and Jeff Osborn

2. Conduct upstream fishway passage counts of adult Pacific lamprey;
3. Complete a literature review of the effectiveness of upstream lamprey passage measures implemented at other hydroelectric projects in the Columbia River Basin;
4. Investigate and implement reasonable and feasible upstream fishway modifications to provide safe, timely and effective volitional Pacific lamprey passage;
5. Implement a monitoring program, such as through the use of radio telemetry, to evaluate fishway modifications;
6. Develop a plan and implement reasonable and feasible measures to address effects on downstream adult passage if any effects are identified through the monitoring program;
7. Once the effectiveness of monitoring has been ensured, ~~Go~~ conduct monitoring every 10 years to ~~determine~~ confirm the success of any modifications, using radio telemetry;
8. Monitor juvenile Pacific lamprey impingement and implement reasonable and feasible measures to address ongoing Project-related effects, if any;
9. Determine juvenile Pacific lamprey presence/absence and relative abundance in the Reservoir;
10. Identify and implement off-site measures to address unavoidable impacts to achieve NNI; and.
11. Participate in regional Pacific lamprey research efforts.
12. Monitor and coordinate with regional management activities, as appropriate~~efforts.~~

SECTION 1: INTRODUCTION

The relicensing process for the Rocky Reach Hydroelectric Project (Project) brought fisheries agencies, tribes, and interested parties together in a Natural Resources Working Group (NRWG) that provided an opportunity for comprehensive review of current and future management priorities for fish resources potentially impacted by ongoing Project operations. The NRWG was established to identify issues, develop study plans, review study reports, and develop long-term management plans for fish and wildlife species. The NRWG consisted of representatives from the USDA Forest Service, U.S. Fish and Wildlife Service (USFWS), NOAA Fisheries, Washington Department of Ecology (WDOE), Washington Department of Fish and Wildlife (WDFW), U.S. Bureau of Land Management (BLM), the Colville Confederated Tribes (CCT), Yakama Nation (YN), Columbia River Inter-Tribal Fish Commission (CRITFC), and other interested parties.

Technical groups were formed for each comprehensive plan; e.g., resident fish, white sturgeon, bull trout, Pacific lamprey, and wildlife due to the complexity of issues surrounding each species and so that agency experts could focus on meetings pertaining to their specific expertise. A subgroup of the NRWG, the Pacific Lamprey Technical Group (PLTG), comprised of the USFWS, WDOE, WDFW, YN, CRITFC, and Chelan PUD, completed this Pacific Lamprey Management Plan (PLMP). Upon the effective date of the New License, the Settlement Agreement's Rocky Reach Fish Forum (RRFF) will assume responsibility for meeting to share information, coordinate efforts, and make recommendations regarding the implementation of the PLMP, which will be reviewed, in consultation with the RRFF, on a periodic basis to allow for planning and future adjustments during the term of the New License and any subsequent annual licenses.

This PLMP contains sections that describe the background of the Pacific lamprey (~~section~~ [Section 2](#)); the relicensing and other studies conducted to determine ongoing Project-related impacts, if any, on Pacific lamprey (~~section~~ [Section 3](#)); and specific Protection, Mitigation, and Enhancement measures (PMEs) developed for achieving the goals and objectives for Pacific lamprey to be implemented during the term of the New License and any subsequent annual licenses (~~section~~ [Section 4](#)).

SECTION 2: BACKGROUND

2.1 Life History

The Pacific lamprey (*Lampetra tridentata*) is a jawless anadromous fish widely distributed in western North America and eastern Asia. The fish are indigenous to the Columbia River system. In general, their historic distribution coincides with that of Pacific salmon. The current distribution of Pacific lamprey in the Columbia River and tributaries extends to Chief Joseph Dam and to Hells Canyon Dam in the Snake River. The Pacific lamprey is parasitic on various ocean fishes for one to two years. After maturing in the ocean, they migrate upstream in the Columbia River in the summer/fall and spawn over a gravel nest, up to 2-feet in diameter, in shallow water the following spring. Adults die soon after spawning. Juveniles live in streams for five to six years before entering the ocean to become parasitic. They appear to have little impact on marine fish populations and do not feed when they move into streams to spawn.

2.2 Species Status

Conservation groups filed a lawsuit against the U.S. Fish and Wildlife Service (USFWS) in May 2004 to compel the agency to act on their January 27, 2003 petition to list four species of lamprey, including Pacific lamprey. On October 1, 2004, the USFWS initiated its 90-day finding process as part of a settlement with the conservation groups. On December 22, 2004, the USFWS announced that a petition to list four species of lamprey did not contain sufficient information to warrant further review at that time. The agency said it will continue to work with others on efforts to conserve lamprey and their habitat.

Over the past four years, Pacific lamprey adult counts at the mid-Columbia River dams have increased to levels similar to those observed in the 1960s. Counts from the 1960s through the mid-1970s showed a decrease, followed by a leveling out of the counts through the 1990s. Causes of population decline may include: 1) passage problems for adult and juvenile lamprey migrating past dams; 2) declining conditions of spawning and rearing habitat in freshwater; 3) a decline of prey available in the marine environment; 4) industrial and agricultural pollution; 5) urbanization; 6) dewatering of streams; and 7) adult losses at sea (Close, 2002, Moser and Close, 2003a; 2003b).

2.3 Adult Fishway Counts

Pacific lamprey are observed in the upstream fishway and downstream bypass of mid-Columbia River dams, with peak passage typically occurring between March and October. Mid-Columbia River populations of adult lamprey passing Rocky Reach Dam ranged from about 1,000 to 17,000 from 1961 to 1969, then declined to less than 200 by 1976 (Mullan et al., 1986). The number of lamprey counted at Rock Island Dam showed a similar decline, with counts stabilizing at about 400 per year from 1977 to 1982. However, over the past four years, lamprey adult counts at the mid-Columbia River dams, including Rocky Reach Dam, have increased, reaching 767 in 2000, 805 in 2001, 1,842 in 2002, 2,521 in 2003, and 1,043 in 2004. Adult Pacific lamprey counts at Rock Island Dam were 822, 1,460, 4,878, 5,000, and 2,362 for the same years. Chelan PUD began counting 24 hours per day at the Rocky Reach upstream fishway

in 1996. Regardless of counting methodology, annual lamprey passage counts have increased in recent years.

2.4 Spawning and Rearing

There is no documentation that Pacific lamprey use the mainstem Columbia River for spawning. However, a literature review conducted during the relicensing process (BioAnalysts, 2000) indicates that juvenile lamprey may use the mainstem for rearing.

SECTION 3: STUDIES AND EVALUATION OF PROJECT EFFECTS

Little specific information is currently known about the life history or status of Pacific lamprey in the vicinity of the Project. They are known to occur in the Wenatchee, Entiat and Methow rivers, and they migrate through the mainstem Columbia River. Adult Pacific lamprey passage is documented at the Rocky Reach and Rock Island Dam fishways. It is unknown whether lamprey use the mainstem Columbia for spawning.

In 2004, the NRWG determined that Chelan PUD should conduct a study at the Project to evaluate passage of adult Pacific lamprey through the upstream fishway and to document any downstream passage from the fishway (Chelan PUD, 2005). The purpose of the study was to identify potential upstream passage impediments in the upstream fishway.

3.1 Adult Lamprey Telemetry Study

Research at other mainstem Columbia River dams has identified areas within upstream fishways that are problematic for lamprey passage (Moser et al., 2003). In response to this research, radio-telemetry was used in 2004 to assess adult Pacific lamprey passage behavior and success through the Rocky Reach Dam upstream fishway (Figures 1 and 2). The telemetry system employed in the study was installed and operational at the tailrace and upstream fishway, as well as the turbine intakes and spillbays. These systems were designed and installed by BioAnalysts, Inc., and have been used previously to assess passage of adult salmonids, primarily bull trout.

The following sections describe briefly the telemetry system, as well as capture and tagging methods employed in the study.

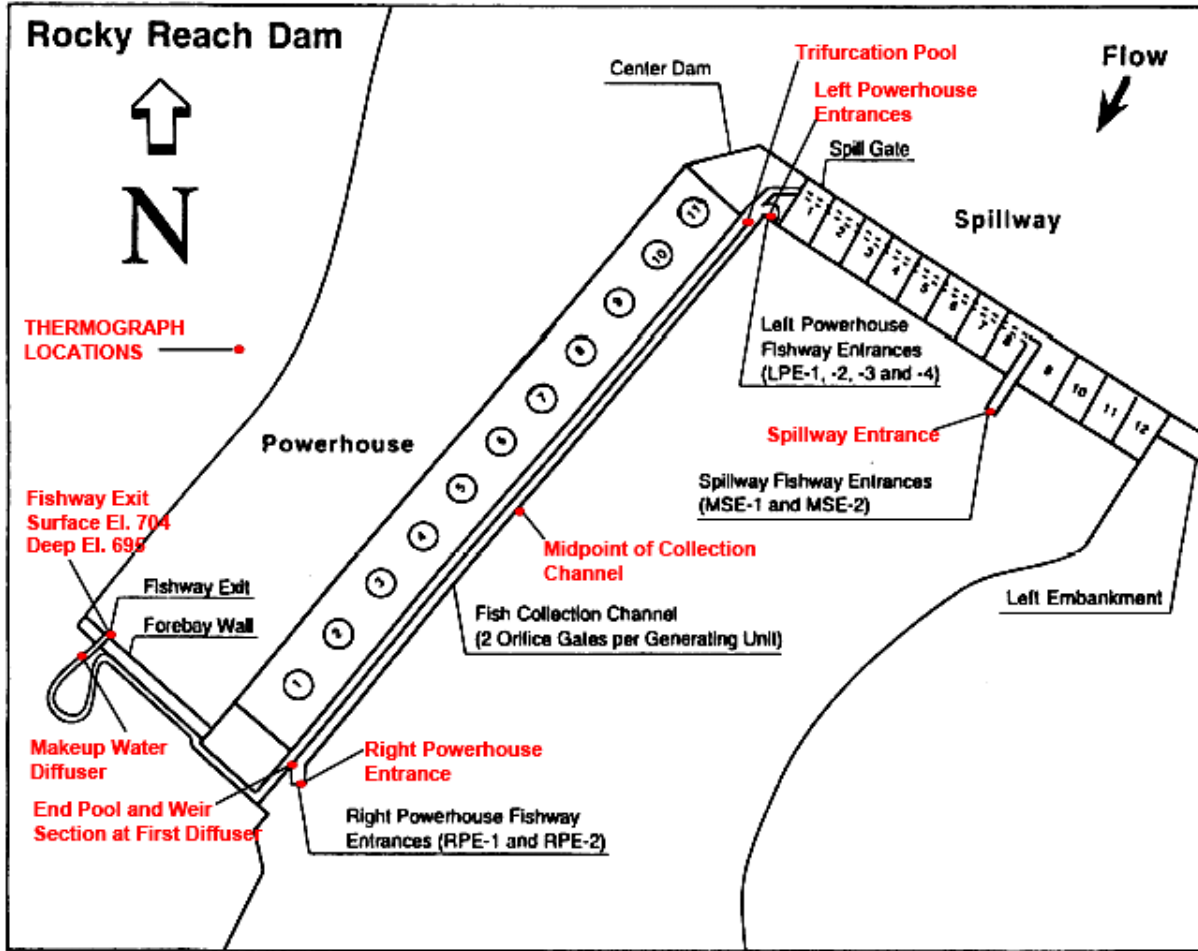
3.1.1 Sample Size

For this study, BioAnalysts released a total of 150 radio-tagged lamprey: 125 downstream of Rocky Reach Dam and 25 within the Rocky Reach Dam fishway. The downstream release provided information on tailrace residence time and passage behavior within the fishway.

3.1.2 Fish Capture

One of the most challenging aspects of this study was the capture of test fish. Throughout the mainstem Columbia River system, a number of capture methods have been employed at different hydroelectric projects, with varying degrees of success. At Bonneville Dam, NOAA Fisheries has been conducting lamprey passage studies since 1996 (Vella et al., 1999a; Vella et al., 2001; Ocker et al., 2001; and Moser et al., 2002a). In those investigations, Pacific lamprey were captured with a passive trap that straddled an overflow weir within the fishway. For Bonneville Dam, this type of trap was effective in capturing an adequate number of test fish.

A similar trap was employed by Grant County PUD in 2001 at Priest Rapids Dam, but with minimal success (Tom Dresser, personal comm.). However, the same traps, borrowed from Grant PUD for this study, deployed in the Rocky Reach Dam fishway proved very effective in capturing sufficient numbers of adult lamprey for tagging.



THERMOGRAPH LOCATIONS IN ROCKY REACH FISHWAY - 2004

Figure 1: Rocky Reach Hydroelectric Project Upstream Fishway

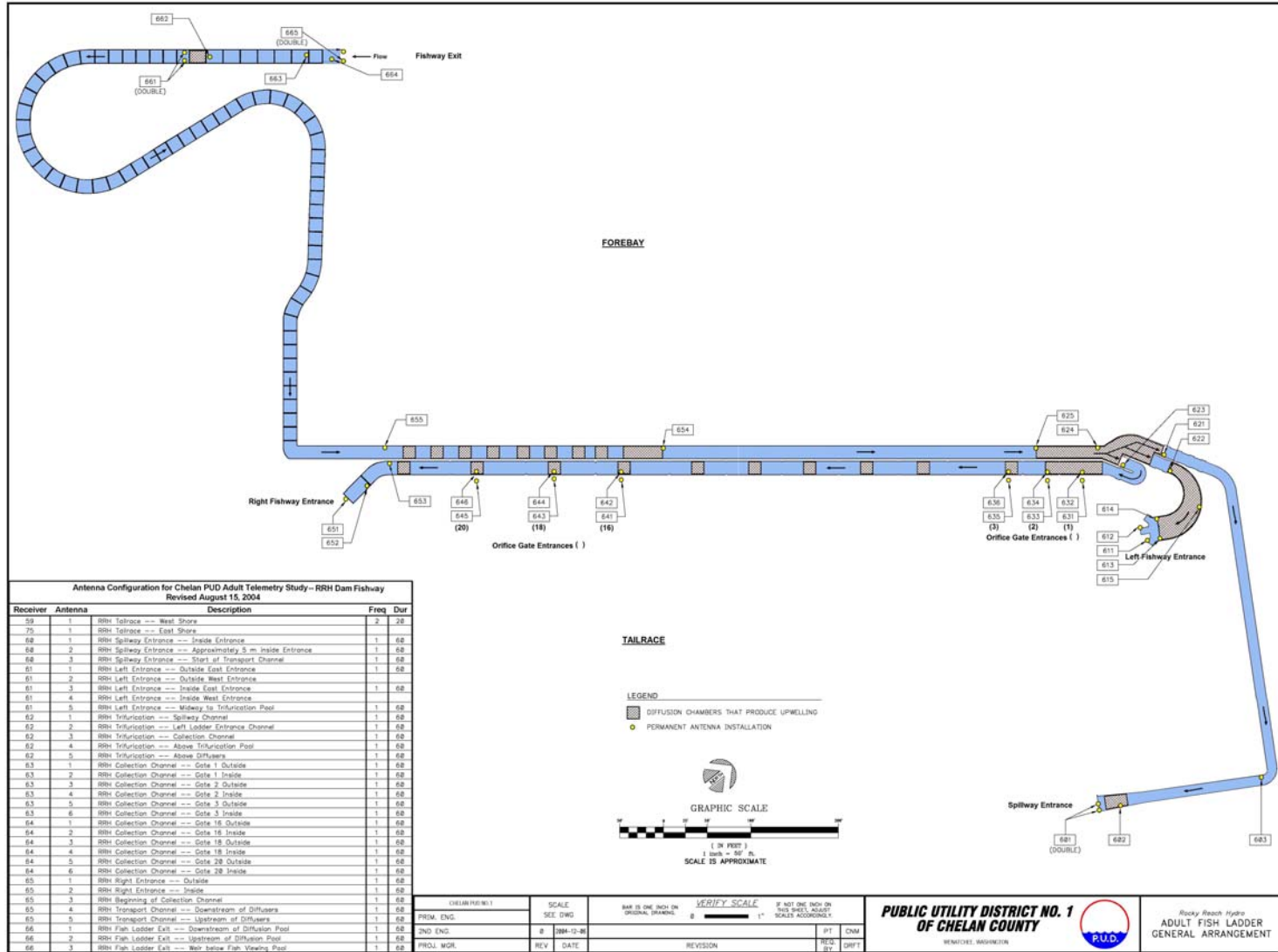


Figure 2: Rocky Reach Upstream Fishway Detail

3.1.3 Tagging Techniques

After collection, test fish were transported to the tagging facilities where they were held briefly until tagging. Implantation of transmitters into Pacific lamprey was accomplished surgically, using techniques described by Close et al. (2003), with some modifications based on methods described in Stevenson et al. (2002).

After tagging and transport to the release vessel, lamprey were held throughout the day to facilitate recovery. Based on a morning tagging schedule, this provided six to seven hours of recovery time.

3.1.4 Release of Tagged Fish

For the downstream release, equal numbers of lamprey were released along the east and west shore approximately 4.3 miles downstream of the Rocky Reach Dam, near Confluence State Park. The purpose of releasing the fish well downstream of Rocky Reach Dam was to ensure that they had opportunity to distribute horizontally within the river channel. Adequate mixing horizontally within the channel as fish approach the Project was necessary to eliminate potential bias associated with entrance selection and, possibly, migration rate through the fishway.

For the fishway release, fish were placed back into a 52-quart cooler and transported by hand cart to the release location. The coolers were lowered back into the fishway by rope with the vessel door open, allowing the lamprey to exit.

3.1.5 Monitoring

To assess passage of Pacific lamprey through the upstream fishway, BioAnalysts used a telemetry system currently deployed at the dam as part of the adult bull trout passage study. As noted previously, this system provided tailrace residence time, migration rate through the upstream fishway, and identified downstream passage through the Project.

3.1.6 Tributary Monitoring

While tributary monitoring was not an objective of this study, the migration of Pacific lamprey up both the Wenatchee and Entiat rivers was monitored. This was accomplished using systems that were installed previously to monitor bull trout migration and required little effort to maintain. The Wenatchee River site detected fish that migrated upstream into the Wenatchee basin rather than through the Dam. The Entiat River site detected fish that successfully migrated through the Dam and entered the Entiat basin; this may help corroborate detection data gathered at the Dam.

3.1.7 Mobile surveys

Mobile surveys of the study area were also not an objective of the study. However, BioAnalysts conducted occasional boat surveys within the Rock Island and Rocky Reach reservoirs to locate tagged fish that were not detected by fixed-telemetry sites, or those that had questionable detection histories at the Project. BioAnalysts conducted three surveys during the field study (August-September) period that included all of the Rock Island Reservoir and the Rocky Reach Reservoir upstream to Daroga State Park. These surveys assisted in confirming or refuting potential adult downstream migration past the Project.

3.2 2004 Radio-Telemetry Study

Radio-tagged lampreys were released over the course of nine weeks during the period of August 2 to October 1, 2004 at three different release locations. Release locations R₁ and R₂ were located downstream of Rocky Reach Dam near the Odabashian Bridge, on the east and west shores, respectively. A total of 125 lampreys were released at these downstream locations, with 63 lampreys released at R₁ and 62 at R₂. An additional 25 lampreys were released at R₃ within the upstream fishway approximately 60 m downstream of the upstream fishway exit.

Of the 125 radio-tagged lampreys released approximately 7 kilometers downstream of the Project, 93.6% were detected at the dam. Of those fish, 94% entered the fishway. Both of these estimates are similar to estimates observed at Bonneville, Priest Rapids, and Wanapum dams. Of the fish that entered the Rocky Reach Dam fishway, a total of 55.5% exited the ladder. This estimate was slightly higher than observed at Bonneville Dam during the period of 1997 through 1999, and considerably higher than observed at Priest Rapids in 2001. However, the Rocky Reach estimate was lower than what was observed at Bonneville Dam in 1996, and at Priest Rapids and Wanapum dams in 2002. The fishway release supplemented the downstream release in assessing fallback through the Project. For comparison, at Bonneville Dam, approximately 85% of the fish released downstream of the Project were detected at the dam. Of those detected at the dam, 35 to 40% successfully migrated upstream and were detected at the upstream fishway exits (Vella et al., 1999a; Vella et al., 2001; Ocker et al., 2001; and Moser et al., 2002a).

Of the fish that exited the upstream fishway (n=79), 21.5% passed downstream through the dam on one or more occasion. However, of those fish, 41.2% successfully re-ascended the fishway, and ultimately exited the fishway. Therefore, the net downstream passage rate at Rocky Reach Dam was 12.7%. This rate was higher than what was typically observed at Bonneville, Priest Rapids, or Wanapum dams.

While the indices provided above are useful in ascertaining the location of potential passage concerns, the metric that provides the best overall picture of lamprey passage is the Net Ladder Passage Efficiency (NLPE). Specifically, NLPE is the proportion of fish detected in the tailrace of the dam that exit the upstream fishway, and which adjusts for downstream passage and re-ascend. At Rocky Reach Dam, the NLPE was 47%. While this metric was not reported for passage at Bonneville, Priest Rapids, and Wanapum dams, it can be derived from those reports (Moser et al., 2002a; Moser et al., 2003; Nass et al., 2003). For the five years of Bonneville Dam research where NLPE can be estimated, the NLPE ranged between 25.7 to 42.1%. For Priest Rapids Dam, the NLPE was 29.2% and 62.3% in 2001 and 2002, respectively. For Wanapum Dam in 2002, the NLPE was 48.9%.

For all projects where estimates are available, including Rocky Reach, lamprey generally approach and enter fishways at a relatively high percentage rate (Table 1). However, of the fish that enter the fishway, a substantial proportion (>50%) do not ascend and exit the fishway system. Based on final detections, of the 125 fish tagged and released downstream of the Project, 40% were last detected downstream of Rocky Reach Dam (33.6% in the tailrace of the dam, and 6.4% within the Rock Island reservoir). Furthermore, 15.2% were last detected within the Project fishway, with 3.2% of the fish residing within the fishway until their transmitters appeared to have expired. Finally, 0.8% of the tagged fish were last detected within the diffusion conduit

beneath the fishway (part of the attraction water system), which provides supplemental water to the upstream fishway.

Table 1: Pacific Lamprey Fishway Passage Comparison²

Location	Dam Detection	Entered Fishway	Exited Fishway	NLPE ³
Bonneville Dam	82.4-93.3%	28.6-88.0%	46.1-50.3%	25.7-42.1%
Priest Rapids Dam	96.8%	62.2-80.3%	27.8-85.7%	29.2%-62.3%
Wanapum Dam	91.8%	62.2-80.3%	82.1%	48.9%
Rocky Reach Dam	93.6%	94%	55.5%	47%

Most of the fish last detected downstream of the Project had at some point entered the fishway, but later descended and exited the fishway into the Project tailrace. For the fish last detected within the fishway, it appears that tag expiration may account for a proportion of those fish. However, 12% of the fish last detected within the fishway were last detected prior to the expected expiration date of their transmitters. Possibly, entry of tagged fish into the diffusion conduit may provide an alternative explanation for the disappearance of some of these fish.

At Rocky Reach Dam, for fish that successfully ascended and exited the fishway, the migration rate from release to the tailrace averaged approximately 6.1 k/day. For this same group of fish, the arithmetic mean time spent in the tailrace and fishway were 5.05 and 2.50 days, respectively, and the collective median time from tailrace to the fishway exit was 7.32 days.

For fish that entered any one of the nine potential entrances, three adult and six orifice gate entrances, to the Rocky Reach fishway, median migration rates from the point of entrance to the trifurcation pool ranged between 1.24 meters(m)/minute to 21.09 m/minute. For these segments within the fishway, migration rates were slowest for fish entering orifice gates (O.G.s) 1-3, and fastest for fish entering the spillway entrance. Mean migration rates through the trifurcation pool from the three potential entry points (i.e., collection channel, left entrance and spillway entrance) ranged between 12.64 to 14.76 m/minute. For fish migrating through the transport channel, which extends from the trifurcation pool to the base of the ladder, the median migration rate was 7.23 m/minute. Finally, the last two sections of the fishway, from the base of the ladder to the ladder flow regulation diffuser (located approximately 60 m downstream of the exit) and from that diffuser to the exit, the median migration rates were 1.03 and 0.09 m/minute, respectively. The last section, from the diffuser to the exit, contains a number of structures, including a diffuser, the public viewing windows, a picket barrier, and the fish counting window and station. From the slow migration rate through this section of fishway, it appears that one or more of these structures delays migration.

² Tabular data extracted from Evaluation of Adult Pacific Lamprey Passage at Rocky Reach Dam Using Radiotelemetry Techniques, 2004. Final report, March 23, 2005 prepared for Chelan PUD by BioAnalysts, Inc and Columbia Basin Research.

³ Net Ladder Passage Efficiency (NLPE) is the proportion of fish detected in the tailrace of the dam that exit the upstream fishway, and which adjusts for downstream passage and re-ascent.

3.3 Findings to Date

The following key findings have been obtained from the 2004 adult radio-telemetry study, numerous years of observations in the Reservoir and tributaries, and from other information sources:

- Pacific lamprey use the upstream fishway;
- Pacific lamprey spawn in the tributaries;
- Juvenile Pacific lamprey rearing occurs in the tributaries, with juveniles also observed at the Dam and in the Reservoir;
- Since the early 1990s, the trend of annual number of adults observed passing the Dam has increased;
- Since 1991, fewer than 20 adult Pacific lamprey per year have been found in the Rocky Reach upstream fishway during winter maintenance, indicating few fish overwinter or become trapped in the fishway (Rainey, personal communication 2005);
- Juvenile Pacific lamprey (macrophthalmia) have been observed using the downstream bypass;
- It is likely that most juvenile lamprey that pass through the turbine intake are within 21 feet of the bottom (based on fyke net studies at Rocky Reach), and below the screens on generation units one and two, the only two screened units at the Project;
- Due to physiologic differences, turbine passage may be less likely to cause harm to Pacific lamprey than salmonids. Studies indicate that because Pacific lamprey do not have a swim bladder and have a flexible body shape, with no operculum, the effects of two primary mechanisms that cause mortality to salmonids during turbine passage are minimal to Pacific lamprey.⁴
- [The 2004 telemetry results suggest that adult passage impediments may exist within the Rocky Reach fishway.](#)

3.3.1 Columbia River Basin Lamprey Technical Workgroup

A regional technical workgroup was developed through the Northwest Power and Conservation Council (NWPCC) to identify critical uncertainties of lamprey research throughout the Columbia Basin. A draft document was available at the time of the writing of this PLMP. In the draft *Critical Uncertainties for Lamprey in the Columbia River Basin: Results from a strategic planning retreat of the Columbia River Lamprey Technical Workgroup*, the regional technical workgroup prioritized a list of critical uncertainties for Columbia River Basin lamprey species (CRBTWG 2005).

⁴ Tests at the Battelle PNNL showed no immediate external injuries or mortalities for lamprey exposed to rapid changes in pressure, and lamprey did not suffer any ill effects at exposure to levels of high differential velocity that injured and/or killed juvenile salmon and shad. Thus, the effects of turbine passage induced pressure change and fluid shear do not appear to cause injury or mortality to juvenile lamprey. The effects of blade strike or indirect effects, such as increased vulnerability to predation following turbine passage, have not been tested. In studies of mortality to fish volitionally passing through a STRAFLO turbine (Annapolis Tidal Generating Station, head range from 1.4-6.8 m), no mortality or injury was observed in 20 sea lamprey captured in nets deployed in the turbine discharge (Gibson and Myers, 2002. Trans. Am. Fish. Soc. 131:623-633).

The draft document is intended to guide lamprey conservation, management, research, and funding decisions in the Columbia River Basin. The prioritized list of critical needs is presented below.

Table 2: Prioritized List of Critical Research Needs for Columbia River Anadromous Lamprey (Source: CRBTWG, 2005)

Ranking	Critical Need	Category
1	Lamprey Status	Imminent
2	Passage	Imminent
3	Population Delineation	Highly Important
4	Limiting Factor Analysis	Highly Important
5	Restoration Activities	Important
6	Biology/Ecology	Important
7	Population Dynamics (Predictive Analyses)	Needed

These priorities helped the Rocky Reach Pacific Lamprey Technical Group develop ~~section~~ [Section 4.2.2](#) of this PLMP as part of the relicensing process for the Project.

SECTION 4: PROTECTION, MITIGATION, AND ENHANCEMENT MEASURES

The goal of the PLMP is to achieve No Net Impact (NNI) on Pacific lamprey through identifying ongoing Project-related impacts, if any, on Pacific lamprey; implementing reasonable and feasible measures to reduce or eliminate such impacts; and implementing on-site or off-site measures to address unavoidable impacts. The PLMP is intended to be an adaptive management approach where strategies for meeting the goals and objectives may be adjusted through a collaborative effort with the relicensing stakeholders based on new information and ongoing monitoring results. The plan is also intended to be consistent with other management plans in the mid-Columbia region. The following objectives were established to identify any negative impacts on Pacific lamprey from ongoing Project operations and fishways, and to develop Protection, Mitigation, and Enhancement measures (PMEs) to reduce or eliminate those impacts, in consultation with the RRFF.

Objective 1: Identify any ongoing Project-related impacts on upstream and downstream passage of adult Pacific lamprey, and eliminate those impacts to the extent reasonable and feasible;

Objective 2: Identify any ongoing Project-related impacts on downstream passage of juvenile Pacific lamprey, and eliminate those impacts to the extent reasonable and feasible;

Objective 3: Identify any ongoing Project-related impacts on the existing reservoir habitat used currently by juvenile Pacific lamprey, and eliminate those impacts to the extent reasonable and feasible;

Objective 4: Identify and implement ~~on-site or~~ off-site measures to address unavoidable impacts to achieve NNI.

Objective 5: Provide funding for regional research to support Objectives 1 through 4.

The information in this section outlines the proposed PMEs for Pacific lamprey through the term of the New License. The PLMP emphasizes a monitoring program that will necessitate future consultation with the RRFF to evaluate monitoring results and develop recommendations for program direction.

The PMEs contained in this management plan will: 1) protect, mitigate, and enhance lamprey resources ~~for the term of the New License~~; 2) ensure that the ongoing operation of the Project will not adversely impact lamprey; 3) minimize the effect of any incidental injury or mortality to lamprey that may occur as a result of Project operation or Project effects to lamprey habitat; and 4) ensure adequate monitoring and reporting of results.

4.1 Objective 1: Identify Any Ongoing Project-related Impacts on Upstream and Downstream Passage of Adult Pacific Lamprey, and Eliminate Those Impacts to the Extent Reasonable and Feasible

The 2004 radio telemetry study indicated that the Project may have an effect on Pacific lamprey upstream passage, though more information is necessary before Chelan PUD and the RRFF can identify and implement any appropriate modifications to the upstream fishway. As part of this PLMP, Chelan PUD shall undertake the following measures to more specifically identify further passage impediments and determine whether modifications used to facilitate Pacific lamprey passage at other hydroelectric dams in the Columbia River Basin may be applicable to the Rocky Reach Dam. In addition to the updated literature review described in ~~section~~ [Section](#) 4.1.3, Chelan PUD, [in consultation with the RRFF](#), may elect to conduct further Pacific lamprey studies to gather additional information before implementing fishway modifications recommended by the RRFF.

Under this objective, Chelan PUD will begin to implement and evaluate any reasonable and feasible improvements to the upstream fishway at Rocky Reach Dam identified, pursuant to ~~section~~ [Section](#) 4.1.4 and 4.1.5, as soon as possible, but no later than five years of the effective date of the New License. The measures described in sections 4.1.3 through 4.1.5 may be repeated as a tiered approach to achieving safe, timely and effective upstream passage for adult Pacific lamprey, if the evaluation of the initial modifications does not achieve effective upstream passage of Pacific lamprey. Since the proposed long-term monitoring will be repeated every 10 years of the New License, opportunities for future modifications exist if study results suggest they are reasonable and feasible. Specific activities associated with this objective include:

4.1.1 Fishway Operating Criteria

Chelan PUD shall continue to operate the upstream fishway at Rocky Reach Dam in accordance with anadromous fish criteria described in the annual Chelan PUD fish passage plan (e.g., Grassell, 2005). Chelan PUD shall prepare the annual fish passage plan in consultation with the RRFF.

4.1.2 Adult Passage Counts

Chelan PUD shall maintain, using the most current technology, annual adult Pacific lamprey counts in the fishway at Rocky Reach Dam for the term of the New License and any subsequent annual licenses.

4.1.3 Upstream Passage Improvement (Tier I) Literature Review

Unless the RRFF concludes that it is not necessary, Chelan PUD shall, within one year of the effective date of the New License, complete a literature review of the effectiveness of upstream lamprey passage measures implemented at other hydroelectric projects in the Columbia River Basin and evaluate whether it would be reasonable and feasible to implement similar measures at Rocky Reach Dam.

4.1.4 Upstream Passage Improvement (Tier I) Modifications to Improve Upstream Passage

As soon as possible, but no later than five years of the effective date of the New License, Chelan PUD shall, in consultation with the RRFF, design and implement reasonable and feasible upstream passage improvement measures identified under ~~section~~ [Section](#) 4.1.3, if any, at the

Rocky Reach Project. Passage measures will be designed to eliminate impediments to volitional passage of Pacific lamprey through the fishway. Passage measures may include an interim trap-and-haul program if other measures do not effectively address ongoing Project impacts.

4.1.5 Upstream Passage Improvement (Tier I) Evaluation of Modifications

Within one year following the implementation of any upstream passage improvement measure at Rocky Reach Dam, Chelan PUD, [in consultation with the RRFF](#), shall monitor the effectiveness of such measures ~~for an appropriate period of time~~ ~~period of one year~~, using the methods described in ~~section~~ [Section 3.1](#) of this plan. If, as determined by the RRFF, the results of the monitoring indicate that passage has not significantly improved as a result of such measure, Chelan PUD shall, in consultation with the RRFF, develop and implement a plan to identify additional reasonable and feasible passage improvement measures, if any. Measures described in sections 4.1.3, 4.1.4, and 4.1.5 above will be repeated, [following the principles of adaptive management](#), until adult passage success at the Project is similar to the best passage rates found at other hydroelectric projects in the Columbia River basin.

Biological objectives for supporting designated uses for Pacific lamprey are shown in Table 3. Measures outlined in Table 4 include the development of criteria for adult Pacific lamprey passage success. For example, the results of baseline telemetry studies could serve as a building block for evaluating the effectiveness of future reasonable and feasible modifications. Data resulting from such studies could be considered by the RRFF in determining the success or failure of such modifications.

4.1.6 Adult Downstream Passage

If, [in consultation with the RRFF](#), significant ongoing Project effects are identified through the investigations described in sections 4.1.3, through 4.1.5, Chelan PUD shall, in consultation with the RRFF, develop a plan and implement reasonable and feasible measures to address such effects.

4.1.7 Periodic Monitoring

Every ten years during the term of the New License, or on a schedule recommended by the RRFF, Chelan PUD, [in consultation with the RRFF](#), shall monitor ~~for a one-year period~~ adult Pacific lamprey passage through the Rocky Reach fishway, [for an appropriate period of time](#), using methods similar to those described in ~~section~~ [Section 3.1](#) of this PLMP. If, [in consultation with the RRFF, it is determined that](#) such monitoring program does not confirm the effectiveness of the passage improvements previously identified by the monitoring conducted under ~~section~~ [Section 4.1.5](#), Chelan PUD shall, in consultation with the RRFF, identify and implement additional reasonable and feasible passage improvement measures, if any.

4.2 Objective 2: Identify Any Ongoing Project-related Impacts on Downstream Passage of Juvenile Pacific Lamprey, and Eliminate Those Impacts to the Extent Reasonable and Feasible

Chelan PUD's current monitoring of turbine intake screens indicates that harm to juvenile lamprey is negligible. As part of the PLMP, Chelan PUD will continue monitoring to assure that this remains the case. Specific activities associated with this objective include:

4.2.1 Downstream Passage of Juvenile Pacific Lamprey

Chelan PUD shall operate the Project's downstream bypass in accordance with the operation criteria for anadromous salmonids and compatible bull trout migration guidelines set forth in the Rocky Reach Anadromous Fish Agreement and Habitat Conservation Plan and the annual Rocky Reach Fish Passage Plan, as approved and/or amended by the Rocky Reach HCP Coordinating Committee.

Table 3: Biological Objectives for Supporting Designated Uses for Pacific Lamprey

Designated Use	Biological Objectives	Evaluation timeframe	Actions if objective achieved	Alternative Management Actions	Plan Action
Adult upstream and downstream Migration	Success similar to best experience at other similar projects (Adult upstream fish passage as defined by the RRFF)	By year 7	(Continuous reassessment every 10 years)	Develop and implement a plan in consultation with the RRFF to address identified problems	Sections 4.1.1-4.1.7; 4.4; and 4.5
Juvenile downstream migration	Maintain safe, effective, and timely volitional passage Criteria (as defined by the RRFF)	TBD by RRFF with 5 year review by RRFF		Develop and implement a plan in consultation with the RRFF to address identified problems	Sections 4.2.1-4.2.2; 4.4; and 4.5
Rearing	Avoid and Minimize project impacts on rearing	By year 7		Develop and implement a plan in consultation with the RRFF to address identified problems	Sections 4.3; 4.4 ; and 4.5
Overall Combined Goal	No Net Impact	TBD by RRFF		Develop and implement a plan in consultation with the RRFF to address identified problems	Section 4

Table 4: Summary of Criteria for Achievement of Objectives for Pacific Lamprey

Designated Use	Objective	Measured Parameter	Evaluation Timeframe	Actions if Objective Achieved	Actions if Objective Not Achieved	Plan Action
Adult Lamprey	Assess adult upstream passage	Fishway counts using most current technology	Annual	Maintain Action. No additional action needed.	Research and implement reasonable and feasible alternative technologies for more accurate counts	Section 4.1.1
	Assess adult upstream passage	Modify fishways if impediments identified	Within 5 years of New License	Maintain Action. No additional action needed.	Investigate and implement reasonable and feasible technologies shown to be effective at other dams	Section 4.1.2
	Assess adult upstream passage	Conduct radio-telemetry monitoring studies	One year after fishway modifications	Maintain Action. No additional action needed.	Investigate and implement reasonable and feasible technologies shown to be effective at other dams	Section 4.1.3
	Assess adult upstream passage	Conduct radio-telemetry monitoring studies	Every ten years	Maintain Action. No additional action needed.	Develop and implement a collaborative plan to address identified problem(s)	Section 4.1.3
	Assess adult upstream passage	Adult passage success	5 year intervals	Develop criteria for success (e.g. outcome-based standard). Maintain Action. No additional action needed.	Develop and implement a collaborative plan to address identified problem(s)	Section 4.1.4
Juvenile Lamprey	Assess juvenile downstream passage	Monitor turbine intake screens for impingement	Annual	Discontinue monitoring per RRFF. No additional action needed.	Investigate and implement reasonable and feasible technologies shown to be effective at other dams	Section 4.2.1
	Assess juvenile downstream passage	Support regional research	Annually (recommended by the RRFF)	Maintain Action. No additional action needed.	Investigate and implement reasonable and feasible technologies shown to be effective at other dams	Section 4.2.2
	Assess juvenile reservoir rearing habitat; overall Project impact	Determine reservoir juvenile presence/absence and relative abundance	Within 3 years of New License	Maintain Action. No additional action needed.	Develop and implement a collaborative plan to address identified problem(s)	Sections 4.3.1 and 4.3.2

4.2.2 Juvenile Impingement Monitoring and Reporting

During the juvenile lamprey migration period, Chelan PUD will monitor potential lamprey impingement on turbine intake screens to assure impingement rates remains negligible until such time as the RRFF recommends that monitoring is no longer necessary. This monitoring will include the continued use of video equipment during weekly intake screen cleaning operations at turbine units 1 and 2, in order to videotape the diversion screens during every deployment of the brush car.

Chelan PUD shall ensure that videos are viewed in real time as the brush car is deployed, ~~and that any lamprey impingement is recorded and~~ and shall notify the RRFF of any substantial incidents of lamprey impingement. ~~reported annually to the RRFF.~~ All video tapes shall be archived by Chelan PUD. In addition, Chelan PUD shall provide an annual report summarizing any lamprey impingements observed in the videos to the RRFF.

If significant ongoing Project effects are identified through the investigations described in this section, Chelan PUD shall, in consultation with the RRFF, develop a plan and implement reasonable and feasible measures to address such effects.

4.3 Objective 3: Identify Any Ongoing Project-related impacts on the existing reservoir habitat used currently by juvenile Pacific lamprey, and eliminate those impacts to the extent reasonable and feasible

Identifying and addressing potential Project-related impacts on juvenile lamprey rearing habitat in the Reservoir is part of the PLMP. Within three years of the effective date of the New License, Chelan PUD shall evaluate juvenile lamprey presence and relative abundance in habitat areas that may be affected by ongoing project operations. As part of this measure, Chelan PUD shall use existing aerial photographs, bathymetry, shoreline slope, velocity, and substrate characteristics to segregate habitat types into those areas with high, medium, and low potential for use by juvenile lamprey, and assess presence/absence in areas that may be affected by Project operations using electroshocking sampling (if permitted). If electroshocking is not permitted, alternative measures will be evaluated (Moser and Close, 2003a; 2003b).

If significant ongoing Project effects are identified through the investigations described in this section, Chelan PUD shall, in consultation with the RRFF, develop a plan and implement reasonable and feasible measures, if any, to address such effects. If, reasonable and feasible measures cannot be determined to address such effects, Chelan PUD, in consultation with the RRFF, will identify and implement on-site or off-site measures, in order of preference, to address unavoidable impacts.

4.4 Identify and Implement Off-Site Measures to Address Unavoidable Impacts to Achieve NNI

~~Potential off-site mitigation measures may be identified concurrently with implementation of on-site measures.~~ Chelan PUD will, in consultation with the RRFF, identify and implement ~~on-site and~~ off-site measures to ~~address unavoidable losses at the Project to~~ achieve NNI, if monitoring or other research efforts identify unavoidable losses at the Project that cannot be addressed on-site ~~such impacts occur.~~ Potential off-site measures may be identified concurrently with

implementation of on-site measures, particularly if early monitoring results indicate that on-site measures alone will not achieve NNI. ▸

4.5 Provide Funding for Regional Research to Support Objectives 1 through 4

The Columbia River Basin Lamprey Technical Workgroup (CRBTWG), comprised of various fishery management agencies, tribes, and utility biologists, prioritized a list of critical uncertainties for lamprey, and developed research strategies for resolving those uncertainties in its report, *Critical Uncertainties for Lamprey in the Columbia River Basin: Results from a strategic planning retreat of the Columbia River Lamprey Technical Workgroup* (CRBTWG, 2005). Pursuing these research strategies is expected to result in greater understanding of Pacific lamprey life history, behavior, and potential ongoing Project impacts, which will assist Chelan PUD in addressing potential ongoing Project impacts.

Table 5 lists critical uncertainties, research strategies, and the number of years necessary to implement the strategies. If new monitoring methodologies become available, Chelan PUD will, in consultation with the RRFF, evaluate and implement those methods, as appropriate, for monitoring lamprey at the Project. To help implement these research strategies, Chelan PUD shall make available up to \$700,000 in year one of the New License to support lamprey research efforts occurring in years one through 10 of the New License. Such annual funding would cease once Chelan PUD determines, in consultation with the RRFF, that such research efforts succeed substantially in identifying ongoing Project impacts, or that the information that these monies were spent on is obtained.

The intent of this funding is to contribute to the knowledge base of Pacific lamprey ecology in the region so that better management decisions can be made regarding Project operation and facility modifications. The RRFF will recommend the use of the proposed funding in order to provide flexibility as priorities change. Funding under other sections in the PLMP will be used for reasonable and feasible fishway modifications, etc.

Table 5: Regional Research Strategies for Pacific Lamprey

Critical Uncertainty (rank)	Potential Strategy	Suggested Number of Years
Lamprey Status (1)	<ul style="list-style-type: none"> • Review historic databases to better understand historic distributions and abundance • Define, improve, and continue historic distribution and abundance indices (e.g., dam counts, tribal harvest records, smolt trap collections, etc) • Coordinate information exchange with existing and future projects not targeting lamprey specifically • Develop standardized sampling protocols for juvenile lamprey in reservoirs 	Continuous
Passage (2)	<ul style="list-style-type: none"> • Develop regional technology to improve to adult fishway passage • Tagging technology development (longer-life adult tag; tags for juveniles) • Identify sources of test fish (juveniles) • Monitor downstream passage hydro effects 	Yrs. 1-10
Population Delineation (3)	<ul style="list-style-type: none"> • Supplement existing libraries of genetic markers for lamprey (e.g., microsatellites, single nucleotide polymorphisms) • Build and maintain lamprey tissue collections from the Columbia River Basin 	Yrs. 1-3
Limiting Factor Analysis (4) and Restoration Activities (5)	<ul style="list-style-type: none"> • Document habitat preferences and habitat availability for all life stages of anadromous lamprey • Provide funding for pilot Pacific lamprey restoration projects <ul style="list-style-type: none"> - Develop, implement, and evaluate lamprey-specific restoration projects (restoring natural processes in the absence of information on limiting factors) - Develop, implement, and monitor reintroduction methods (e.g., transplantation, hatchery production) 	Yrs. 1-10

SECTION 5: LITERATURE CITED

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