LAKE CHELAN FISHERY FORUM
2009 ANNUAL WORK PLAN

LICENSE ARTICLE 404
SETTLEMENT AGREEMENT CHAPTER 6

FINAL

February 11, 2009

Developed by the
National Park Service, USDA Forest Service, and
Washington Department of Fish and Wildlife
in coordination with, and adopted by, Chelan PUD

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SECTION 1: INTRODUCITON

On November 6, 2007, Public Utility District No. 1 of Chelan County (Chelan PUD) filed the Lake Chelan Fishery Plan (LCFP) pursuant to Article 404 of the Federal Energy Regulatory Commission Order on Offer of Settlement and Issuing New License dated November 6, 2006 for the Lake Chelan Hydroelectric Project. This report satisfies Article 404 requirements for annual reporting of activities associated with the following:

1. Tributary Barrier Removal
2. Fish Stocking
3. Entrainment Sampling
4. Monitoring and Evaluation Program

The Federal Energy Regulatory Commission (FERC) approved the LCFP on December 4, 2007. A component of the Lake Chelan Settlement Agreement (SA) and Lake Chelan Fishery Plan is for the National Park Service (NPS), USDA Forest Service, and Washington Department of Fish and Wildlife (WDFW) to develop and adopt an annual work plan describing monitoring and evaluation measures in Lake Chelan to be implemented in the upcoming year and a report on activities completed the previous year.

It is a requirement of Chelan PUD's Lake Chelan license to make available $20,000 each year, plus an additional $20,000 in matching funds, to be used for implementing measures contained in the annual Lake Chelan Fish Monitoring and Evaluation Plan.

This annual work plan, developed in coordination with Chelan PUD and adopted by the NPS, USDA Forest Service, and WDFW, describes the methods and schedule used to demonstrate compliance with efforts to restore and enhance, where feasible, native fisheries in Lake Chelan and its tributaries, and to support the lake's recreational sport fishery.

The goals of the LCFP are to: 1) provide guidance for the management of the fishery resources in Lake Chelan; 2) protect native fish populations while maintaining a healthy recreational sport fishery in Lake Chelan; and 3) develop a monitoring and evaluation program to assess the efficacy of management actions.

The primary Lake Chelan Fishery Forum (LCFF) management objectives are to:

1. Emphasize restoration/enhancement of native species, where feasible;
2. Support the recreational sport fishery;
3. Manage the lake elevation to enhance tributary production and recreation;
4. Determine compatibility of management actions with potential future bull trout re-introduction;
5. Develop a monitoring and evaluation program that provides flexibility for future changes in both implementation and the monitoring and evaluation program;
6. Monitor and address entrainment of fish from Lake Chelan into the Project intake.

SECTION 2: POTENTIAL MONITORING AND EVALUATION MEASURES

The following list of potential monitoring and evaluation measures is meant to capture projects that could be done in the future and will be evaluated annually by the LCFF. Specific measures to be implemented in 2009 are described in Section 3.

2.1 Westslope Cutthroat Trout

The current ongoing and planned future fish management goal for Lake Chelan is to beneficially alter the abundance and composition of fish species in the lake. Multiple methods are in progress or will be used in the future, such as altered fishing regulations, a change in stocking practices, and removal of lake tributary alluvial barriers to spring spawning fish to accomplish this goal (Lake Chelan Fishery Plan 2007). The monitoring and evaluation efforts listed below are needed to determine the success of these fish enhancement efforts and to signal the possible need of adaptive changes.

The goal for Westslope cutthroat trout (WSCT) is to increase significantly the abundance of WSCT in lake tributaries and the lake itself, for these fish to eventually replace themselves naturally, and fish to contribute to the sport fishery. To reach this goal the following objectives must be met:

1) WSCT hatched from eyed egg or fry stocking in lake tributaries must survive to maturity, spawn and contribute to increased natural production.

2) A sufficient number of the catchable size WSCT must escape harvest and recruit to the spawning run in order to substantially increase natural production.

3) The catchable size WSCT must eventually replace the catchable size RBT in the sport fishery.

4) A majority of anglers fishing Lake Chelan need to accept the change in species.

To determine the results of the creel survey and spring spawning surveys a database must be constructed. Data will be analyzed and evaluated to determine if our efforts are meeting the above goal and objectives.

2.1.1 Comprehensive Creel Surveys

To ensure results from creel surveys on Lake Chelan are useful and relevant the survey methods must be comparable to those used in the past by Duke Engineering and Services (DES 2000a), Hagen 1997, and Brown 1984. The methods outlined here are designed with this in mind.

The main purpose of the survey is to: 1) determine the relative composition of fish species and origin (naturally produced or hatchery released) contributing to the sport fishery; and 2) determine what species of fish anglers prefer to catch.

Annual creel surveys are designed to monitor and determine the contribution of WSCT, rainbow trout (RBT), lake trout, kokanee, smallmouth bass and burbot to the sport fishery in the entire lake including that portion of the lake in the Lake Chelan National Recreation Area (LCNRA). It is important to determine how much annual angling opportunity is being provided by WDFW fishery management efforts in the recreation area of the National Park. Surveys should be conducted every three years beginning in 2009.

2.1.2 Tributary Spring Spawning Surveys

Beginning in 2009, tributary WSCT and RBT abundance surveys (48 days) will be conducted once every 3 years in some of the following tributaries: Twenty-five Mile, First, Mitchell, Fish, Grade, Gold, Prince, Safety Harbor, Pyramid, Graham Harbor, Coyote, Castle, Deep Harbor and Lone Fir creeks. Powers and Tanner (2008) strongly recommended evaluation of the current status of Lake Chelan cutthroat trout spawning populations prior to treatment of fish passage barriers in tributary streams.

During the 2009 spawning season (April-June) USDA Forest Service fish biologists will perform spawning ground surveys in the adfluvial zones of Mitchell, Gold, Grade, and Safety Harbor Creeks according to the methodology of the Lake Chelan Comprehensive Management Plan (Viola and Foster 2002). Survey frequency is expected to be one survey per stream per week. Sexual maturation, the onset of spawning, and embryo development are significantly regulated by the "thermal experience" of the fish population of interest. Accordingly, water temperature data loggers will be deployed in survey streams starting with the first (pre-spawning) survey and remain in place until late-September. Data loggers will be programmed to record water temperature every 30 minutes.

As part of this effort, surveyors will search for evidence of "shoal spawning" in the shallower waters near tributary mouths and other potentially suitable sites such as Deer Point. Shoal spawning observations will be made from a slow-moving boat where the bottom is visible from the surface. USDA Forest Service surveyors will be equipped with drysuits to allow them to opportunistically perform closer inspections of suspected shoal spawning as well as searching for pre-spawn staging by cutthroat near tributary mouths. This will require one or two days per week for an expected 10 weeks for a maximum effort of 20 USDA Forest Service crew-days. Prince Creek will be surveyed opportunistically depending on weather and availability of the USFS boat.

Estimated Budget and Schedule:

Year	Task	Total $	Requested $	USFS Matching $
2009 Apr-Jun	Install temperature data loggers and Conduct weekly spawning surveys at 4 tributary adfluvial zones incl. opportunistic shoal and snorkel surveys (GS9 & GS11 Fish Bios for total of 20 crew-days	$12,242	$6121	$6121
	USFS boat fuel	$500	$250	$250
	Vehicle (1 month & mileage estimate)	$494	$247	$247
	Supplies and equipment	$200	$100	$100
	Data Mgt. and Reporting (GS9 Fish Bio. for 5 person-days)	$1350	$675	$675
	2009 Estimated Totals	**$14,786**	**$7,393**	**$7,393**

2.1.3 Tributary Estimates of Juvenile Cutthroat and Rainbow Trout Abundance

Beginning in 2009 and continuing into 2010, and every third and fourth year thereafter, WDFW will sample First, Mitchell, Fish, Grade, Gold, Prince, and Safety Harbor creeks to obtain information on adfluvial WSCT and RBT population abundance, age class composition and other biological characteristics. If time and man power allow all or some of the following additional seven creeks may also be sampled in 2009: Twenty-five Mile, Pyramid, Graham Harbor, Coyote, Castle, Deep Harbor and Lone Fir creeks. If not, these creeks will be surveyed in 2010. This sequence of sampling effort will begin again in 2012 and continue into 2013.

Methods used for assessing tributary abundance of juvenile WSCT and RBT will be electrofishing techniques similar to those described in Brown (1984) and DES (2000a). Data gathered from tributary abundance surveys will be compared to those conducted by Brown (1984) and DES (2000a) to determine the population trend of WSCT in tributaries surveyed, with the intent being an increasing WSCT population trend if management actions described in this section prove to be effective.

Estimated Budget and Schedule:

Year	Task	Total $	Requested $	WDFW Matching $
Fall 2009 (every 3 years)	Conduct estimates of juvenile cutthroat and rainbow trout abundance in seven selected tributary (2 Scientific Technicians and 1 Biologist for a total of 42 man-days	$12,100	$6,050	$6,050
	Travel (Lodging when needed and per diem)	$1,000	$1,000	-0-
	Boat and Vehicle (0.5 months)	$700	$700	-0-
	Supplies and equipment	$1,000	$1,000	
	Data Mgt. and Reporting (1-Biologist for 5 man-days)	$1,100	$550	$550
	2009 Estimated Totals:	**$15,900**	**$9,300**	**$6,600**
Fall 2010 (every 3 years)	Conduct estimates of juvenile cutthroat and rainbow trout abundance in an additional seven tributaries (2 Scientific Technicians and 1 Biologist for a total of 42 man-days	$12,463	$6,232	$6,232
	Travel (Lodging when needed and per diem)	$1,030	$1,030	-0-
	Boat and Vehicle (0.5 months @ $600/month)	$721	$721	-0-
	Supplies and equipment	$1,030	$1,030	
	Data Mgt. and Reporting (1-Biologist for 5 man-days)	$1,133	$567	$567
	*(Includes a 3% cost increase) **2010 Estimated Totals:**	**$16,377***	**$9,580***	**$6,799***

2.1.4 Monitor Progress Toward Restoration of Native Westslope Cutthroat Trout in the Stehekin River.

<u>Stehekin River cutthroat and rainbow trout spawner surveys</u>:

Objectives: The objective is to monitor trends in abundance of cutthroat and rainbow trout spawners (April 1- June 1) at 10 to 12 index sites in the lower 10 miles of the Stehekin River. Results will be used to evaluate progress towards restoration of adfluvial/fluvial westslope cutthroat trout and management efforts directed at reduction of non-native rainbow trout in the lower 10 miles of the Stehekin River.

Methods: Initial habitat surveys in the side-channels and tributaries will be completed to select index sites based on presence of suitable spawning gravels and flows. Other considerations will include the feasibility of conducting snorkel surveys during the May – June period of high flows and potential stability of candidate index sites for long-term monitoring. The number of index sites and their length will be dependent on results of the initial habitat suitability survey. However, the goal is to provide a representative sample of approximately 10 to 12 sites with survey lengths of 10 to 20 channel widths. Approximately 3 to 5 snorkel surveys will be conducted at each of the index sites starting on April 1 of each year and ending on June 1 (fewer surveys may be conducted at mainstem index sites if flows are too high for conducting snorkel surveys).

Estimated Budget and Schedule: (NOTE: Habitat assessment also used for Kokanee (OBJ II)

Year	Task	Total $	Requested $	NPS Matching $
Spring 2009 (every 3-5 years)	Conduct habitat assessment and selection of index sites. (2 –GS5/6/7 Bio Techs for total of 20 man-days and 1- GS11 Ecol. for 10 man-days)	$7000	$3500	$3500
	Travel (Ferry and per diem)	$900	$900	-0-
	Vehicle (0.5 months @ $800/month)	$400	$400	-0-
	Supplies and equipment	$500	-0-	$500
	Data Mgt. and Reporting (1- GS11 Ecol. for 10 man-days, GIS Support-5days)	$4600	-0-	$4600
	2009 Estimated Totals:	**$13,400**	**$4800**	**$8600**
2009 + (Annual)	Conduct biweekly spawner surveys at all index sites. (2 –GS5/6/7 Bio Techs for total of 40 man-days)	$6000	$6000	-0-
	Travel (Ferry and per diem)	$1400	$1400	-0-
	Vehicle (1.25 months @ $800/month)	$1000	-0-	$1000
	Supplies and equipment	$500	-0-	$500
	Data Mgt. and Reporting (1- GS11 Ecol. for 10 man-days)	$3400	-0-	$3400
	2009 + Estimated Totals	**$12,300**	**$7400**	**$4900**

Monitor frequency of non-native rainbow genetic introgression in native cutthroat trout in the Stehekin River:

Objectives: Monitor the level and frequency of hybridization between non-native rainbow trout and native cutthroat trout at 2 Stehekin River locations upstream from the Bridge Creek confluence and 2 downstream locations. Results will be compared with baseline data reported by Ostberg and Rodriguez (2006) to evaluate progress towards cutthroat trout restoration in the watershed.

Methods: Non lethal tissue samples will be collected from 40 fish at each of four sampling locations. Sampling locations correspond to reach numbers designated in Ostberg and Rodriguez (2006) publication.

- Location 1 (upper Stehekin; SR6 and SR7- pure westslope cutthroat)
- Location 2 (Stehekin River above Bridge Creek confluence; SR3 and SR4)
- Location 3 (Stehekin River below Bridge Creek confluence; SR1 and SR2)
- Location 4 (lower Stehekin River below confluence of Agnes Creek; previously unsampled)

Forty fish will be collected by electrofishing and angling at each of the four locations. Genetic analyses will determine the frequency of rainbow trout alleles and percent admixture of rainbow trout for each sample area following methods in Ostberg and Rodriguez (2006). This project is proposed to be completed at least once every 5 years.

The initial sampling occurred between 2001 and 2003 and it is recommended that it is repeated in 2010. Results will be compared with those from Ostberg and Rodriguez (2006) to determine the status of rainbow trout introgression with native westslope cutthroat trout.

Estimated Budget and Schedule:

Year	Task	Total $	Requested $	NPS Matching $
2010	Collect fish samples at all five locations. (4 –GS5/6/7 Bio Techs for total of 20 man-days)	$4000	-0-	$4000
	Travel (Ferry and per diem)	$400	-0-	$400
	Vehicle (0.25 months @ $800/month)	$200	-0-	$200
	Supplies and equipment	$500	-0-	$500
	USGS –BRD Lab analyses, Data Mgt. and Reporting	$6000	$6000	-0-
	2010 Estimated Totals:	**$11,100**	**$6000**	**$5100**

2.2 Kokanee

Kokanee are the most sought after fish in Lake Chelan (Brown 1984; DES 2000a). Maintaining a popular kokanee sport fishery in Lake Chelan is a high priority. To maintain this, kokanee should be managed to maintain their abundance at a mean size acceptable to anglers, but at a level of abundance that does not substantially hinder efforts to restore native species.

Goals and objectives for Lake Chelan are to: 1) produce consistently good fishing; and 2) maintain an abundance of kokanee at a level that does not substantially hinder our efforts to restore native species.

2.2.1 Creel Surveys

In order to manage the kokanee population in Lake Chelan, data must be collected to guide development of a Lake Chelan Kokanee Management Plan. Sampling the current population abundance and age composition will be done through conducting a creel survey sometime between May 1 and June 31 annually. Every third year this survey should be part of the comprehensive creel survey stated previously.

Sampling of fish size by age, population composition by age and catch-per-unit-effort (CPUE) of the current population during the spring fishing season should provide an estimate of the up-coming fall spawning escapement. All of the fish that will become spawners in the fall are available for harvest each spring. This information can be used to grossly predict the upcoming fall spawner abundance and determine whether additional spawn should be taken to supplement the egg deposition of the natural spawning.

Estimated Budget and Schedule:

Year	Task	Total $	Requested $	WDFW Matching $
2009 (Annual)	Conduct Creel survey to collect information to allow an estimate of CPUE, mean fish length by age and age composition of the population. (1 Scientific Technician for a total of 6 man-days)	$2,000	$1,000	$1,000
	Fish age determination from scale and/or otoliths samples	$700	$350	$350
	Boat and Vehicle (0.5 months)	$300	$300	-0-
	Supplies and equipment	$150	$150	-0-
	Data Mgt. and Reporting (1-Biologist for 3 man-days)	$550	$275	$275
	2009 Estimated Totals:	**$3,700**	**$2,075**	**$1,625**

2.2.2 Fall Spawning Surveys

Chelan PUD has conducted annual Lake Chelan spawning ground surveys for kokanee since 1984. The purpose of these surveys is to document the annual trends of kokanee spawning populations within the Lake Chelan drainage (Stone and Fielder 2004). Two tributaries of the Stehekin River, Company Creek and Blackberry Creek, have been used as index reaches since 1984 because a majority of kokanee production from the Stehekin originates from in these tributaries. Additional tributaries to Lake Chelan that have been included in the annual kokanee spawning ground surveys are: Mitchell, Gold, Grade, Safety Harbor, Prince, Fish, First, and Twenty-five Mile creeks.

Surveys have been conducted approximately twice monthly between August 31 and October 30. Crews conduct surveys by walking in or along the streams and counting all live kokanee. Tally counters are used to keep track of fish numbers. Large masses of kokanee are estimated in some pools located in Company and Blackberry creeks (Stone and Fielder 2004).

The LCFF has requested that Chelan PUD continue to conduct these annual kokanee spawning grounds surveys beginning in the fall of 2007. Chelan PUD will continue to conduct these surveys to maintain sampling method continuity and comparability in the long record of estimated kokanee escapement that has been established through the past license term.

2.2.3 Mainstem Stehekin and Side Channel Spawning Surveys

The intent of the snorkel surveys is to develop a better estimate of the total number of kokanee being produced in the Stehekin River and to track changes in distribution of spawners in the watershed. Initial kokanee spawning snorkel surveys have been conducted in side channel habitat of the mainstem Stehekin River (Reed Glesne, pers. com.). Kokanee spawning surveys conducted during the previous license focused on index reaches of tributaries to Lake Chelan and the Stehekin River (Fielder 2000; Stone

and Fielder 2004). Significant kokanee production could be emanating from the mainstem and side channel habitat of the Stehekin River that is not being assessed using current survey methods (DES 2000b).

To assess this additional potential kokanee production, snorkel surveys will be conducted every 3 to 5 years, beginning in 2010, in side channels and mainstem reaches of the Stehekin River. A probabilistic sample of index reaches will be selected that facilitates estimation of the entire kokanee escapement in the Stehekin River.

Assess kokanee spawner escapement and distribution in the lower 10 miles of the Stehekin River mainstem, side-channels, and tributaries:

Objectives: Every 3 to 5 years, beginning in 2010, complete an expanded kokanee spawner survey in the Stehekin mainstem channel, side-channels and tributaries to estimate total escapement. In addition, the suitability of mainstem and off-channel habitat will also be quantified at 3 to 5 year intervals (Funds for habitat survey are proposed in Section 2.1.4.A, rainbow and cutthroat spawner surveys, to be completed in the spring of 2009). Results will be used to calibrate annual index station escapement to total escapement and to evaluate spawner distribution in the study area.

Methods: Kokanee spawner habitat suitability surveys will be conducted during the late fall low-flow period on all mainstem and off-channel habitat in the lower 10 miles of the Stehekin River. A representative random sample of spawner survey segments will be drawn from the target populations of all suitable mainstem habitat and all suitable off-channel habitat. Four biweekly spawner surveys will be conducted at all sites during September and October.

Estimated Budget and Schedule:

Year	Task	Total $	Requested $	NPS Matching $
2010 (Every 3-5 yrs.)	Conduct Kokanee Spawner Surveys (2 – GS7 Bio Techs for total of 30 man-days)	$6000	$6000	-0-
	Travel (Ferry and per diem)	$2000	$2000	-0-
	Vehicle (1.5 months @ $800/month)	$1200	-0-	$1200
	Supplies and equipment	$800	-0-	$800
	Data Mgt. and Reporting (1- GS11 Ecol. for 10 man-days, 1- GS11 GIS Specialist for 5 -days, 1-GS5/6/7 Bio Tech for 5 man-days)	$6000		$6000
	2009 Estimated Totals:	**$16,000**	**$8000**	**$8000**

2.3 Burbot

The LCFF believes that monitoring burbot population dynamics should be an important component to the monitoring and evaluation program. However, methods for assessing the burbot population in Lake Chelan need to be developed. Developing these methods will be a future task for the LCFF.

2.4 Smallmouth and Largemouth Bass

The LCFF believes that monitoring smallmouth and largemouth bass population dynamics should be an important component to the monitoring and evaluation program. However, methods for assessing the bass population in Lake Chelan need to be developed. Developing these methods will be a future task for the LCFF.

2.5 Bull Trout

The LCFF believes that the monitoring of any future population and/or individual occurrences of bull trout in Lake Chelan should be an important component to the monitoring and evaluation program. Monitoring of this species at this time should include documentation of incidental occurrences during associated fish monitoring and evaluation program activities. Standard metric measurements, physical condition, and location of fish within Lake Chelan during these occurrences should be documented and provided to the LCFF for review.

2.6 Bioenergetics Food Web Model

The LCFF intends that development of the bioenergetics food web model will continue into the future after funding from Chelan PUD is exhausted. Information collected during implementation of the Monitoring and Evaluation program will be used to update the model. Additionally, the LCFF may chose to fund aspects of food web model development in future years using funds dedicated to implementing the Monitoring and Evaluation program.

SECTION 3: MEASURES TO BE IMPLEMENTED IN 2009

The following are Monitoring and Evaluation Program measures that will be implemented in 2009.

3.1 Continue Bioenergetics Food Web Model Development

Stated in the Lake Chelan Settlement Agreement is the following: "…Chelan PUD shall make available $100,000 (2002 dollars) to a contractor selected by Chelan PUD, after consultation with the LCFF, to develop a food web model for Lake Chelan…" Initial development of a bioenergetics-based food web model was conducted by researchers from the University of Washington (UW) from 2004 to 2007 with funding and support provided by the NPS, USDA Forest Service, WDFW, and the Lake Chelan Sportsman's Association. UW researchers recommended the following analyses to be conducted in 2008 in order to refine and apply the data currently in-hand to further food web model development:

1. Develop visual foraging models to estimate consumption of pelagic prey by lake trout and Chinook salmon under varying scenarios of predator and prey density and distribution.

2. Test fish stocking strategies to determine which techniques allow for the least number of newly stocked fish to be lost to predation.

3. Improve existing diet data by
    a. Identifying salmonid prey found in predator stomachs to species level using genetic analysis.
    b. Analyzing stomach samples of warm-water fish collected by WDFW.

4. The researchers also suggested that the lake managers begin collecting data necessary to track lake trout population and demographic trends in the Wapato Basin.

The LCFF recommend funding for continued development of the Lake Chelan Bioenergetics Food Web model for 2008. A proposal from the UW research team is included in Appendix A. In accordance with the License Settlement Agreement, Chelan PUD will make available $100,000 (adjusted to 2008 dollars is approximately $115,000) for the contract with the UW for the food web model development.

The following is an update from the UW research team on progress made with the food web study in 2008 presented to the LCFF on October 22, 2008 using the funding described in the previous paragraph:

The main objective of the second phase of our research is to estimate the predation impacts of lake trout (and potentially Chinook salmon) on kokanee

under a set of alternative fishery management scenarios. Over the last six months, we have been collecting new field data, analyzing our existing samples, and compiling information from the literature to move towards this goal. This summer, we used hydroacoustics to characterize the distribution of kokanee and their predators during the day-dusk-night time sequence. A large amount of predation typically takes place during dusk, when kokanee have left the protection of schools but enough light is still available for predators to see them. We collected light penetration and water turbidity data during these sampling trips as well to allow us to estimate how effectively predators can search for prey in Lake Chelan. These data will drive visual foraging models specific to each predator species. A foraging model for lake trout has been already published and tested against field data, but no such model currently exists for Chinook salmon. We are reviewing the existing literature on Chinook salmon foraging behavior to develop a preliminary Chinook foraging model.

We are also working on follow-up analyses to make the most of the samples collected during the first phase of the study. The outlook is good for the most ambitious of these analyses, using genetics to determine the species of unidentifiable prey from stomach samples. Earlier this summer, we prepared these prey for analysis and delivered them to a fish genetics lab at UW. This lab recently had great success with identifying pollock remains in the stomachs of Chinook salmon captured in the Bering Sea, a system with dozens of potential prey species. They expect to have little trouble assigning species IDs to our samples from the much smaller pool of species present in Lake Chelan. We are excited to be able to put this powerful technique to use in our study. These results will allow us to estimate with greater precision the predation impacts on kokanee and less abundant salmonids like cutthroat trout.

At this stage, we could use some input from the Forum. We plan to simulate the effects of alternative management scenarios on the balance of predators and prey in the lake. Our first step will be to evaluate the status quo, and provide some guidance on whether predator and prey populations are currently in balance. What we need from the managers and stakeholders are some suggestions for other management scenarios you would like us to test. These might include changes in stocking and harvest of kokanee, lake trout, or Chinook. For example:

- If kokanee stocking were reduced by 50%, would predation increase on the naturally spawning kokanee population? If so, how many additional adult equivalent kokanee would be consumed?
- If the Chinook salmon population were enhanced to some level (say 10,000 adults surviving to spawn), how many adult equivalent kokanee would they consume?
- If the Wapato Basin lake trout population were reduced to 50% of its current abundance by encouraging harvest with a derby or bounty, how many fewer adult equivalent kokanee would be consumed?

- If a slot limit were put in place to enhance the abundance of Wapato Basin lake trout greater than 30" total length by 75%, how many additional adult equivalent kokanee would be consumed?

We don't need a list of scenarios right away, but if any interested parties can start thinking about this now, we will solicit your ideas in the near future. We can include other pelagic species (e.g. cutthroat trout) as well, but we will be data limited for rare species. Foraging models are not available for littoral species like pikeminnow and smallmouth bass, so we can answer questions about the current predator-prey interactions of these fish, but it will be difficult to evaluate "what if" type scenarios like for the pelagic species.

Of course, no model is fully realistic and we don't expect our models to predict the future perfectly. Instead, we will be better off treating these scenario predictions as useful tools to help explore management options and tradeoffs, which are best balanced with other data, case histories from similar lakes, and intuition.

The LCFF members considered the proposal by the UW researchers and developed priority lists of potential additional analyses that will be conducted with the remaining budget for model development. The additional analysis will attempt to answer the following 3 questions:

1. If lake trout abundance was reduced (50%, 20%, 10%), how many fewer kokanee, WSCT, and *mysis* would be consumed? What would be the indirect effects be on the kokanee, WSCT, and *mysis* populations?
2. If the triploid Chinook salmon population level was increased (e.g., 10,000) how many adult kokanee, WSCT, and *mysis* would be consumed?
3. Does isotope analysis of stomach contents provide any insight into Lake trout and Chinook predation on WSCT, kokanee, and *mysis*?

The remaining funding, approximately $20,000, of the $115,000 initial total provided by Chelan PUD for the food web model development will be exhausted in mid-2009.

3.2 Tributary Barrier Confirmation and Removal Planning

Tributary barriers identified in the Tributary Barrier Analysis report (DES 2000b) will be reassessed for depth, velocity, and gradient and re-prioritized if necessary. Two methodologies that may be used are: 1) using the Forest Practices Board Emergency Rule and "Oregon Method" used in the 2000 report; or 2) developing a more simplistic method based on the principles of the 2000 methodology to use as a more rapid assessment tool. The USDA Forest Service supports the latter option.

As tributary barriers are documented as either remaining or eliminated, the LCFF will update the tributary barrier removal priority list included in the 2000 report. Once the tributary barrier removal priority list is updated, the LCFF will work with Chelan PUD to implement Lake Chelan Settlement Agreement License Article 6(c) for tributary barrier

removal work, such as investigating barrier removal methods, stream channel rehabilitation design at tributary mouths, contractor selection to conduct work, etc. Actual on-the-ground tributary barrier removal efforts will commence in early 2011, depending upon runoff volume and associated lake elevation.

Tributary barrier removal efforts were scheduled originally to begin in 2009. However, the scheduled was revised due to the following events: delay in selecting a design contractor; need by the design contractor to view tributary mouths in 2009 to observe barriers present and discuss with the consulting team and LCFF potential preliminary design features; time required to secure necessary permits; and time required to secure a construction contractor.

The LCFF conducted a boat tour of tributary mouths in March 2008, touring both the north and south shores from Twenty-five-Mile Creek uplake to Fish Creek. During the tour, LCFF members took numerous photographs of the tributary mouths to initiate photo-documentation of existing tributary mouth conditions and barriers to upstream fish passage. Photographs were posted on the Chelan PUD Lake Chelan Implementation Website. After the conclusion of the tour, Forum members reached consensus that virtually all tributaries observed had barriers, either water depth, water velocity, or gradient, to upstream fish passage at the lake elevation of approximately 1083.0 feet that occurred during the site visit.

The LCFF met again on June 17, 2008 to review Statements of Qualifications (SOQs) submitted by potential tributary barrier removal design consultants, select and consultant, and proceed with implementing the Tributary Barrier Removal Project (TBRP). A design consultant, the Fairbanks Environmental Team, was selected by consensus of the LCFF.

The LCFF reviewed pertinent information regarding watershed conditions of tributaries to Lake Chelan, such as the USDA Forest Service Regional Assistance Teams (RATs) assessment report, USDA Forest Service Lake Chelan Basin fire map of areas burned since 1998, and tributary mouth photographs taken in March 2008. Based on this information, the priority tributaries selected by the LCFF at the June 17, 2008 meeting were Safety Harbor, Mitchell, Grade, and Gold creeks. However, even with the selection of priority tributaries, the LCFF members discussed proceeding cautiously with tributary barrier removal efforts due to the following considerations:

1. Based on the data illustrated by the Lake Chelan basin fire map and recommendations from the Regional Stream Restoration Assistance Team (RATs), significant watershed instability has been documented in most tributaries to Lake Chelan due to recent fires. The instability of the upper watersheds will likely result in high bedload movements for a number of years during high runoff events, which may thwart barrier removal and stream reconfiguration efforts until the watersheds have time to stabilize to a greater extent;

2. The RATs also recommended giving the new lake level operating regime more time to be in affect that may allow tributaries to carve out alluvial deposits on

their own due to high flow events occurring when the lake level will lower than historical elevations during major high runoff events, particularly in the fall and winter; and

3. Allow the WDFW Westslope cutthroat trout restoration program additional time to increase tributary WSCT populations, thereby producing more spawning age adults that could contribute to natural reproduction in the tributaries.

Efforts to implement barrier removal in Lake Chelan tributaries in 2009 in order to avoid further delay will include the following:

1. Conduct a site visit to primary tributaries by the design consultant and LCFF in late march or early April to document existing conditions and discuss concepts for barrier removal and stream mouth restoration;
2. Continue photo documentation of tributary mouth existing conditions;
3. Conduct initial designs of barrier removal and stream mouth restoration; and
4. Initiate acquisition of all required permits to conduct barrier removal and stream mouth restoration efforts.

3.3 Fish Stocking

Article 6(d) and Section 4.6.3 of Chapter 6 of the Comprehensive Plan requires Chelan PUD to make available to the WDFW sufficient funding to rear annually the following resident fish at the Chelan Hatchery for stocking in Lake Chelan:

1. Approximately 5,000 pounds of salmonid fingerlings (for example: 500,000 fish at 100 fish/lb., presently kokanee).
2. Approximately 33,000 pounds of catchable-sized salmonids (for example: approximately 100,000 fish at 3 fish/lb., presently Westslope cutthroat trout (WSCT) and triploid rainbow trout (RBT).

In 2008, WDFW released approximately 50,000 WSCT (at a size of 15 fish/pound) at Lakeside and Mill Bay in March, and approximately 70,000 triploid RBT (at a size of 3 fish/pound) at Lakeside in August and September (Art Viola, WDFW, pers. com.). Approximately 227,000 kokanee fingerlings, taken from broodstock collected in fall 2006 from the Stehekin River, were released into Lake Chelan near the Yacht Club in May (at a size of 75 fish/lb.). Additionally, approximately 175,000 WSCT fry were released into Twenty-five Mile**,** Mitchell**,** Prince, Safety Harbor, Fish, Grade, and First creeks (at a size of 600 fish/lb.) in June and July.

The stocking plan from WDFW for 2009 is shown in the following table (Art Viola, WDFW, pers. com.).

2009 Fish Stocking Plan

Location	Species	Stock	Number	No. Fish/lb	Stocking date
Lake Chelan Tributaries					
Incubators on First Creek	Cutthroat	Twin LK	25,000	Eyed eggs	June
First Creek	Cutthroat	Twin LK	25,000	Fry	June or July
Mitchell Creek	Cutthroat	Twin LK	25,000	Fry	June or July
25-Mile Creek	Cutthroat	Twin LK	25,000	Fry	June or July
Prince Creek	Cutthroat	Twin LK	25,000	Fry	June or July
Grade Creek	Cutthroat	Twin LK	25,000	Fry	June or July
Safety Harbor Creek	Cutthroat	Twin LK	25,000	Fry	June or July
Fish Creek	Cutthroat	Twin LK	25,000	Fry	June or July
Lake Chelan	Cutthroat	Twin LK	50,000	15	March
		ad clipped	(80%)		
	Kokanee	Lake Chelan	227,000	80	Mid May
	Triploid Rainbows	Spokane	50,000	3	August-September
Mill Creek	Cutthroat	Twin LK	3,000	Fry	June or July
	Triploid Chinook[1]	summer	50,000	Fry	March

1 – The triploid Chinook program is not funded by Chelan PUD

3.4 Monitoring and Evaluation Program

3.4.1 Kokanee Spawning Surveys

Chelan PUD will conduct annual fall spawning surveys for kokanee in 2009, as recommended the NPS, USDA Forest Service, and WDFW in consultation with the LCFF. The LCFF requested, specifically, that Chelan PUD conduct the kokanee spawning surveys due to its unique expertise in conducting such surveys in the Stehekin River and tributaries to Lake Chelan since 1984. Survey methodology is described in the Lake Chelan Kokanee Spawning Ground Surveys, 2007 report (Keesee and Hemstrom, 2007). The cost of conducting kokanee spawning surveys in 2009 is estimated to be $12,000.

3.4.2 Habitat Assessment for Stehekin River Cutthroat and Rainbow Trout and Expanded Kokanee Spawning Surveys

Habitat inventory and suitability assessments of Stehekin side channels and mainstem reaches is required for the selection of index sites for monitoring native cutthroat trout, non-native rainbow trout, and kokanee spawner abundance (See Sections 2.1.4. and 2.2.3). Results will be applied to facilitate the following objectives for the lower Stehekin River; 1) the evaluation of progress towards restoration of adfluvial/fluvial westslope cutthroat trout; 2) management efforts directed at reduction of non-native rainbow trout; and, 3) assessment of kokanee management in the basin.

Habitat surveys in the mainstem, side-channels, and tributaries will be completed by the NPS during the spring of 2009 to map all potential habitat suitable for cutthroat, rainbow trout, and kokanee spawning. Results will be used to select representative rainbow trout and cutthroat trout spawner survey index sites, based on presence of suitable spawning gravels and flows. Results will also be used for selecting a random set of kokanee

spawner survey sites that will allow extrapolation of spawner survey counts in the future to provide an overall estimate of kokanee spawners in the Stehekin River.

3.4.3 Lower Stehekin River Cutthroat Trout and Rainbow Trout Spawning Surveys

Beginning in 2009 monitor trends in abundance of cutthroat and rainbow trout spawners (April 1- June 1) at 10 to 12 index sites in the lower 8 to 10 miles of the Stehekin River. Results will be used to evaluate progress towards restoration of adfluvial/fluvial westslope cutthroat trout and management efforts directed at reduction of non-native rainbow trout in the lower 10 miles of the Stehekin River.

Initial habitat surveys in the side channels and tributaries will be completed to select index sites. The number of index sites and their length will be dependent on results of the initial habitat suitability survey (see Sections 2.1.4.A and Section 3.4.2), however the goal is to provide a representative sample of approximately 10 to 12 sites with survey lengths of 10 to 20 channel widths. Approximately 3 to 5 snorkel surveys will be conducted at each of the index sites starting on April 1 of each year and ending on June 1 (fewer surveys may be conducted at mainstem index sites if flows are too high for conducting snorkel surveys).

3.4.4 Tributary Estimates of Juvenile Cutthroat and Rainbow Trout Abundance

Beginning in 2009, and every third year thereafter, WDFW will sample First, Mitchell, Fish, Grade, Gold, Prince, and Safety Harbor creeks to obtain information on adfluvial WSCT and RBT population abundance, age class composition and other biological characteristics. If time and man power allow all or some of the following additional seven creeks may also be sampled in 2009: Twenty-five Mile, Pyramid, Graham Harbor, Coyote, Castle, Deep Harbor, and Lone Fir creeks.

Methods used for assessing tributary abundance of juvenile WSCT and RBT will be electrofishing techniques similar to those described in Brown (1984) and DES (2000a). Data gathered from tributary abundance surveys will be compared to those conducted by Brown (1984) and DES (2000a) to determine the population trend of WSCT in tributaries surveyed, with the intent being an increasing WSCT population trend if management actions described in this section prove to be effective.

3.4.5 Kokanee Creel Surveys

WDFW will sample the current kokanee population abundance and age composition by conducting a creel survey annually sometime between May 1 and June 31. Data analysis from the survey will allow an estimate of CPUE, mean size, and age composition of harvested fish. This information can be used to predict the up-coming fall spawner abundance.

3.4.6 Fish Stocking Monitoring and Evaluation

WDFW will clip adipose fins on all kokanee reared and released into Lake Chelan as part of the fish stocking program. Fin clipped kokanee will provide important information regarding the contribution of hatchery-reared kokanee to the sport fishery (especially

their survival) as identified through creel surveys versus natural production. The cost of fin-clipping hatchery produced kokanee is estimated to be $5,000 annually.

Summary of 2009 LCFP Expenditures

Measure	**Estimated M&E Cost**	**Amount to be provided by Chelan PUD**	**Agency Cost-share**	**Task**
Kokanee Spawning Surveys (PUD)	$12,000	$12,000		Section 3.4.1
Stehekin River Spawning Habitat Assessment (NPS)	$13,400	$4,800	NPS $8,600	Section 3.4.2
Stehekin River Trout Spawning Surveys (NPS)	$12,300	$7,400	NPS $4,900	Section 3.4.3
Juvenile Trout Abundance Surveys (WDFW)	$15,900	$9,300	WDFW $6,600	Section 3.4.4
Spring Trout Spawning Surveys (USFS)	$15,150	$6,450	USFS $8,700	Section 3.4.4
Kokanee Creel Survey (WDFW)	$3,700	$2,075	WDFW $1,625	Section 3.4.5
Fish Stocking M&E (fin clipping) (WDFW)	$5,000	$5,000		Section 3.4.6
Total Survey Costs	$77,450	$47,025	$30,425	
Food Web Model Funding	~$20,000	~$20,000		Section 3.1
Tributary Barriers				Section 3. 2
Fish Stocking	$30,000	$30,000		Section 3. 3
TOTAL	$127, 450	$97,025	$30,425	

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APPENDIX A: FOOD-WEB MODEL PROPOSAL

Food web interactions and fisheries management in Lake Chelan, Phase Two: Refining empirical data and using predictive foraging models to evaluate alternative management scenarios

Dr. David Beauchamp and Erik Schoen

Lake Chelan, a major fisheries and recreation resource for the state of Washington, contains a complex aquatic community of native and introduced fish and invertebrates. When fisheries managers set stocking, harvest, and habitat restoration policies for the lake, they must balance multiple goals that include restoring the native westslope cutthroat trout (*Oncorhynchus clarki lewisi*) population and maintaining popular sport fisheries for kokanee (*O. nerka*) and lake trout (*Salvelinus namaycush*). Effective management for these potentially competing priorities depends on a detailed and accurate understanding of the major food web interactions in the lake. The Lake Chelan Food Web project incorporated two years of seasonal field sampling, laboratory analysis, and bioenergetics modeling to quantify top-down and bottom-up factors limiting key fish species. The first phase of the project is now nearing completion, and the study results will be disseminated via a Masters thesis, two peer-reviewed journal articles, and oral presentations during autumn 2007, including presentations at the annual meetings of the American Fisheries Society in San Francisco and the Washington Lake Protection Association meeting in Chelan. We propose two research directions for the second phase of the project to improve our understanding of the fisheries biology of Lake Chelan: 1) Finish pending laboratory analyses to make full use of the biological samples already collected; and 2) Investigate the likely consequences of alternative management strategies on predator-prey interactions and key fish species, using visual foraging models and existing empirical data.

Pending laboratory analyses for existing samples

Four analyses are proposed. The cost and time demands for each analysis are small relative to the large field sampling effort already undertaken to collect the samples.

A. Determine the species of unidentified salmonid prey using genetic techniques. Of 40 predator stomachs containing salmonid prey, 20 contained salmonids that were unidentifiable from bones, leaving significant uncertainty about the impact of predation on each salmonid species. Identification of these prey fish to the species level would substantially reduce this uncertainty and allow more accurate estimation of predation rates on each salmonid species. This requires preparing all 20 unidentified prey for genetic analysis, as well as samples of known species ID for each salmonid species in lake (lake trout, wild cutthroat trout, hatchery-origin cutthroat trout, rainbow trout, kokanee, Chinook). While preparing these samples, we will measure the body length of each salmonid prey or reconstruct the length based on the lengths of key bones or of the vertebral column. This will allow bioenergetic estimates of predator consumption (in kg) to be scaled to the number and size of prey fish consumed.

B. Process stomach samples collected during littoral sampling by WDFW (n = 197) to augment diet data for littoral species and include samples from the shallowest parts of the Wapato Basin, which were not extensively sampled in phase one of the study. This involves transferring the samples from formalin to ethanol, identifying the diet contents, and entering and analyzing the data.

C. Send lake trout otoliths to an outside lab to corroborate ages determined from opercle bones. 190 lake trout have been aged with opercles. Ages estimated from opercles have been shown to be as precise but less labor-intensive than otolith ages, although the innermost annulus may be obscured on opercles (Sharp and Bernard 1988). By comparing a subset of the opercle ages to independent otolith ages from a reputable aging lab, we can corroborate the ages of the larger sample and identify and correct for any bias in the lake trout age data. Accurate age data are critical because they are used to calculate lake trout growth, survival, and prey consumption rates.

D. Analyze depth-stratified zooplankton samples to determine the vertical distribution of cladocerans during the thermally stratified period. Previous zooplankton density data reflect the total zooplankton density throughout the top 80 m of the water column. Additional samples were collected at a subset of sampling sites and dates using depth-stratified hauls during the summer months. These samples will be used to evaluate the degree of vertical overlap of kokanee and *Mysis* with their preferred cladoceran prey, and determine whether an adequate zooplankton density exists in the depth range occupied by kokanee.

Investigating predator-prey dynamics with visual foraging models

The first phase of the Lake Chelan food web study quantified trophic interactions in the current lake food web, and identified bottom-up and top-down factors limiting fish species of interest. However, if future management actions or environmental change alter predator or prey densities or other habitat characteristics, fish are expected to change their behavior to adjust to those changes. Visual foraging models allow prediction of the behavior of cruising predators like lake trout, cutthroat trout, and Chinook salmon feeding on pelagic prey. While the field data and bioenergetics models used in the first phase of the study allow us to answer questions like “How many kokanee did the Wapato Basin lake trout population consume during 2005?” visual foraging models can predict how many kokanee would likely be consumed if the abundance or distribution of predators or prey were to change in the future. The ability to estimate changing predator-prey interactions under a range of scenarios is clearly desirable for managers, making foraging models a valuable extension of the existing project. A set of management scenarios will be developed in partnership with fishery managers, and could include changes in lake trout, kokanee, or cutthroat trout densities, rebuilding the landlocked Chinook salmon population, or lake warming trends.

Visual foraging models for lake trout and cutthroat trout have been developed and applied to several large, North American lake systems (Beauchamp et al. 1999; Jensen et al. 2006; Mazur and Beauchamp 2006). These models can be adapted to Lake Chelan

using existing field data. A visual foraging model does not currently exist for Chinook salmon, but compiling published and experimentally derived parameters could allow development of a model to estimate Chinook predation within reasonable bounds.

Much of the field data needed to parameterize visual foraging models for Lake Chelan have already been collected, although limited additional sampling will enhance the quality of model predictions. Existing data include seasonal light penetration and thermal profiles from throughout the lake, turbidity measurements throughout the lake during summer 2006, and seasonal pelagic prey distribution determined from hydroacoustic surveys. Turbidity is extremely low in Lake Chelan (~0.5 nephelometric turbidity units; E. Schoen, *unpubl. data*), and is not generally expected to affect predator foraging rates. However, high springtime turbidity at the mouth of the Stehekin River may inhibit predation and provide an important refuge for out-migrating juvenile kokanee and cutthroat trout. Additional directed sampling of turbidity, light penetration, and prey distribution may be valuable during spring runoff and fry out-migration in the Stehekin area. Hydroacoustic data are currently being analyzed to determine the abundance and distribution of kokanee for the bioenergetics-based food web study. These surveys were predominantly conducted at night when kokanee are least likely to school, and are thus easier to identify as individual targets. However, since pelagic predators are often highly active during dawn and dusk, additional sampling during those crepuscular periods may also be a valuable addition.

We propose to apply visual foraging models for lake trout and Chinook salmon to Lake Chelan to estimate the predatory impact of those species on salmonid prey under a set of management scenarios. This involves four parts:

A. Compile current empirical data and literature values to parameterize visual foraging models for the current conditions in Lake Chelan;
B. Determine crucial data gaps and address these with limited additional light penetration, turbidity, and diel hydroacoustic sampling;
C. Compare foraging model results under current conditions to existing empirical data on lake trout distribution and diet to determine whether the model is accurately predicting current predator behavior; and
D. Apply the model to a set of potential future conditions to address specific questions about predation impacts under alternative management scenarios.

Dissemination of results and project timeline:

Results from the pending analyses will be included in the peer-reviewed journal articles generated from phase one of the study. The visual foraging analysis will form the basis for a subsequent journal article. Updates and final project results will be communicated to the Lake Chelan Fishery Forum in written progress reports, at Forum meetings, and/or in individual meetings with fishery managers. Phase two of the study will be completed under the following timeline:

1) Pending analyses for existing samples: January 2008 – June 2008
2) Evaluating management scenarios with visual foraging models, *if no fieldwork is undertaken*: January 2008 – March 2009

3) Evaluating management scenarios with visual foraging models, *with limited additional fieldwork*: January 2008 – June 2009

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Chelan Food Web						Personnel costs						
					Total	Months			Research		Genetics	Lab
First Year Budget (starting January 2008)			months		**Costs**	Lab analyses		RA	Scientist	Hourly	Staff	fees
SALARIES						A-Diet Genetics		0.25		0.75	1	
Principal Investigator: Dr.David Beauchamp	no cost		1	0		B-Littoral diets		0.25		2		
Grad. Research Asst-Ph.D.	$ 1,708	/mo x	15	$ 25,615		C-LT otoliths (50 otoliths)		0.25				1200
Research Scientist	$ 4,200	/mo x	2.5	$ 10,500		D-Depth-Zoop counts		0.25		0.5		
Temporary Hourly Assistance	$ 10	/hr x	3.25	$ 5,730								
						Visual Foraging Model						
BENEFITS								14	2			
Professional	28.7%			$ 3,014				15	2	3.25	1	1200
Graduate Student	10.9%			$ 2,792								
Hourly	11.3%			$ 647								
Total Salaries & Benefits					**$ 48,298**							
SERVICES												
Boat use fee					$ 720							
Hydroacoustic use fee					$ 2,400							
TRAVEL					$ 839							
SUPPLIES												
Lab supplies, boat fuel, software					$ 3,240							
EQUIPMENT					$ -							
GRAD STUDENT OPERATING FEE (Quarterly)	1 summer + 4 academic quarters				$ 13,425							
TOTAL DIRECT COSTS					$ 68,922							
Indirect costs	56.0%				$ 31,078							
TOTAL 1st Year COSTS			actual	68,451	**$ 100,000**							