Diamond Lake Restoration Project

Fisheries Biological Evaluation/Assessment

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PROJECT AREA OVERVIEW

Diamond Lake is located on the Umpqua National Forest in southwest Oregon (Figure 1). The area being analyzed in the Diamond Lake Restoration Project EIS encompasses Diamond Lake, Lake Creek, Lemolo Lake, and the North Umpqua River (Figure 2) down to Rock Creek. The project area includes Diamond Lake proper and Lake Creek, located on the Diamond Lake Ranger District, Umpqua National Forest within the Umpqua River Basin (Figure 3). The project area is bounded to the North by the North Umpqua River, to the South by Crater Lake, to the East by Mt. Thielsen, and to the West by Mt. Bailey. The project area includes all or portions of sections 30 through 32, T27S, R6E; sections 25 and 36, T27S, R5E; sections 4 through 9 and sections 16 through 21, T28S, R51/2E, and sections 1 and 12, T28S, R5E Willamette Meridian, Douglas County, Oregon.

Diamond Lake is a natural lake located at about 5,191 feet elevation. It has a surface area of approximately 3,031 acres and is relatively shallow, with a maximum depth of 48.5 feet and an average depth of 22.5 feet (Eilers and Gubala, 2003). Diamond Lake drains into Lake Creek, which empties into Lemolo Lake, an impoundment on the North Umpqua River. Two other impoundments are located downstream from Lemolo Lake-Toketee Lake and Soda Springs Reservoir. **The dam forming Soda Springs Reservoir is located approximately 33 miles downstream of Diamond Lake, and represents the uppermost distribution of anadromous fish – including coho salmon.** The flow of water from Lemolo Lake and the other impoundments is regulated by PacifiCorp, a public utilities corporation.

Diamond Lake is a high use destination recreation area[1] considered important to the economy of southern Oregon. Originally fishless, the lake has been managed as a recreational trout fishery since 1910. Tui chub were introduced into the lake in the mid-1940's and rapidly overpopulated the lake. In 1954, the Oregon Game Commission constructed a canal near the Lake Creek outlet, lowered the lake level, and treated Diamond Lake with rotenone to eradicate tui chub. The lake was restocked with trout following the rotenone treatment and a thriving fishery was maintained for several decades. In 1992, tui chub were again discovered in Diamond Lake and have since overpopulated the lake for a second time. Associated negative impacts on the recreational fishery and on water quality in Diamond Lake and down stream prompted multiple local, state, and federal agencies to work cooperatively in the exploration of restoration solutions for the lake as summarized below.

[1] Estimates for recreation use at Diamond Lake are approximately 700,000 Recreation Visitor Days per year (meaning continuous or intermittent recreational use for 12 hours by an individual) (USDA 1998).

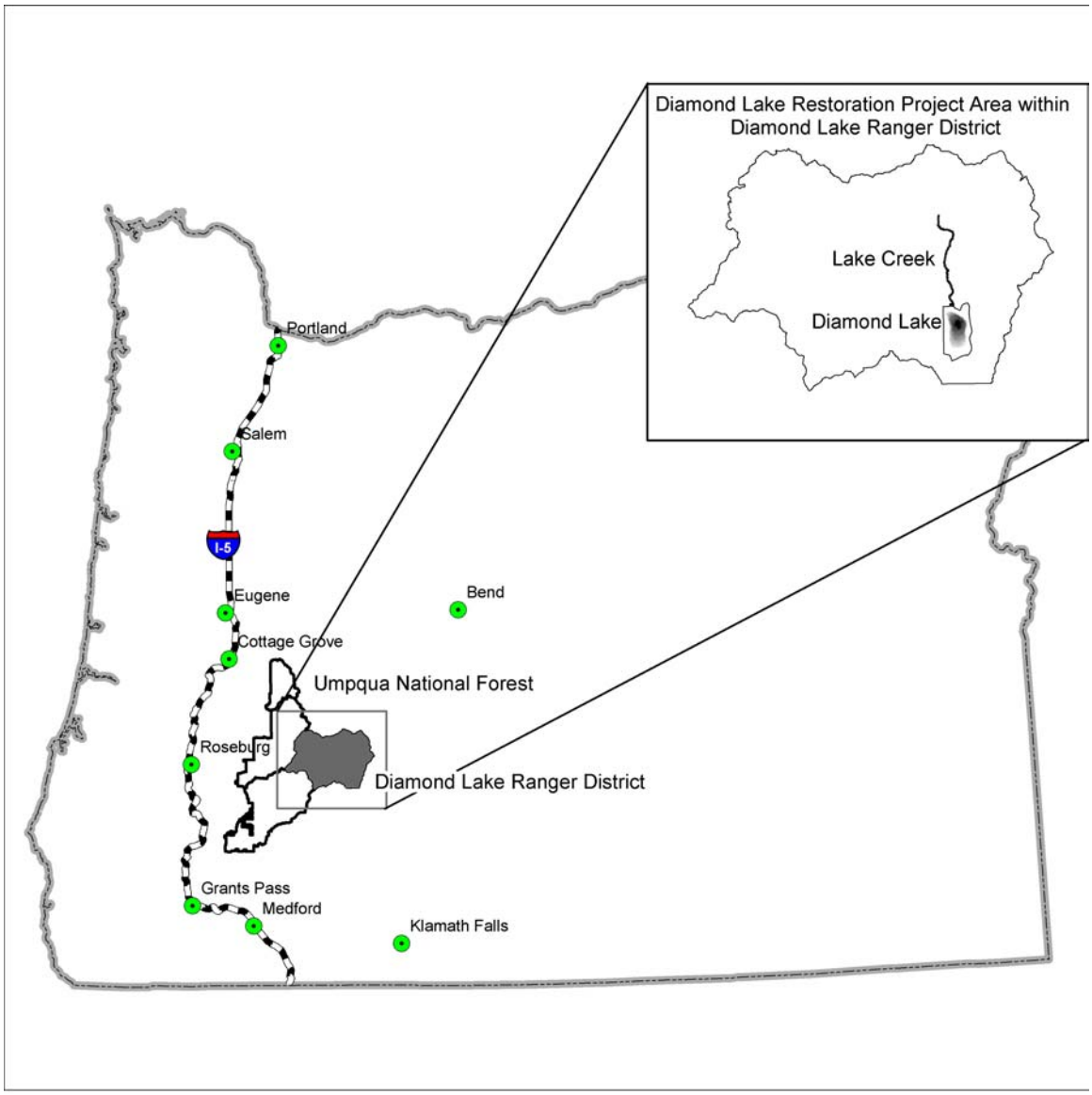

Figure 1. Project Area Location on the Diamond Lake Ranger District, Umpqua National Forest.

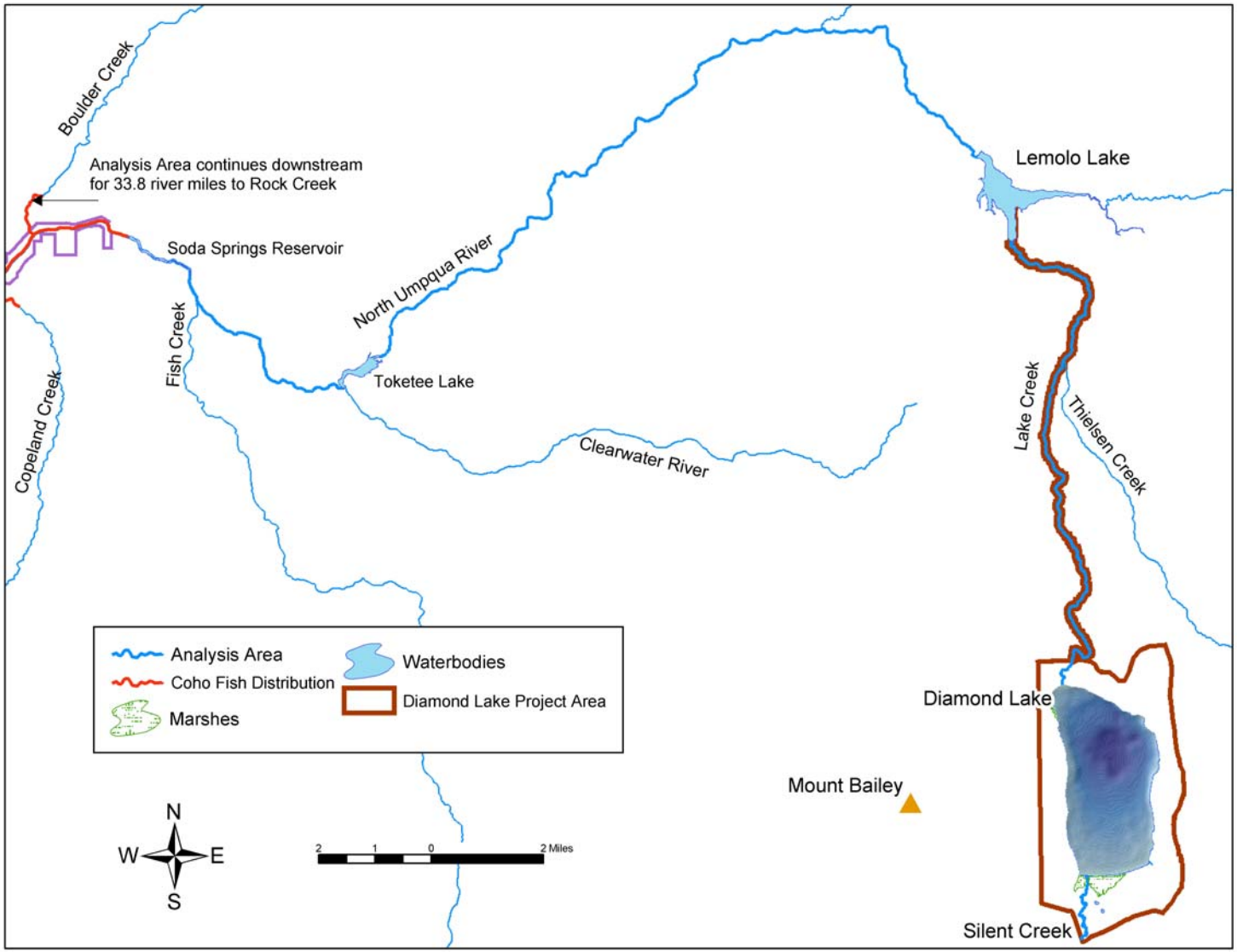

Figure 2. Diamond Lake Restoration Project Area Within the Analysis Area.

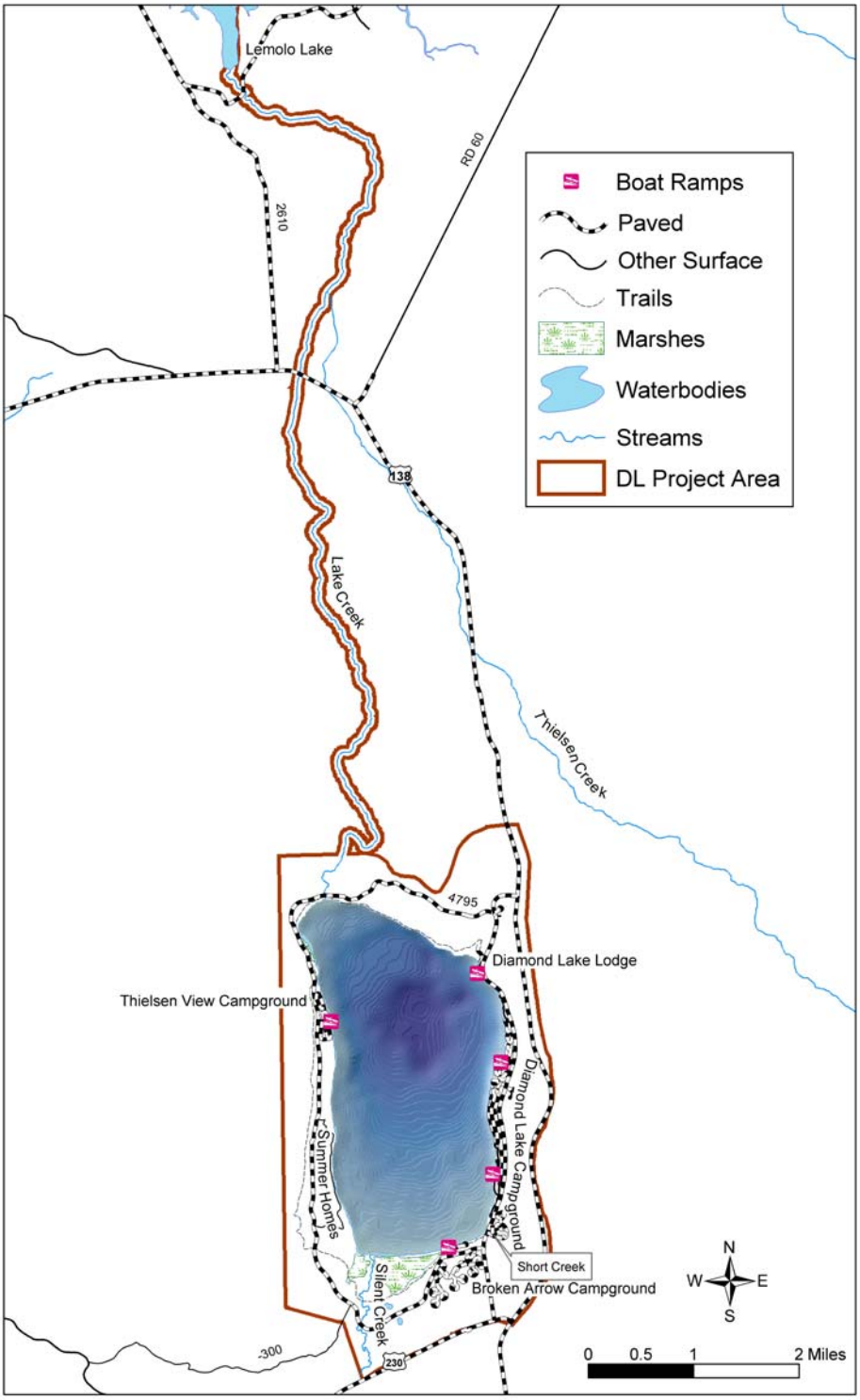

Figure 3. Diamond Lake Restoration Project Area.

PURPOSE OF AND NEED FOR THE ACTION

The Forest Supervisor of the Umpqua National Forest finds there is a need for improvement of Diamond Lake's water quality and recreational fishery. Eradication or control of the existing tui chub[2] (*Gila bicolor*) population is considered essential for accomplishing these objectives[3].

The difference between the existing conditions and the desired conditions defines the purpose and need for action in terms of elements that can be measured and analyzed. These elements are:

Element 1 - Water Quality

Diamond Lake currently does not meet State water quality standards, LRMP Management Area goals, or support the "beneficial uses" of the lake. Diamond Lake is included in the Oregon Department of Environmental Quality's (ODEQ) 303(d) list of "water quality limited" water bodies for the parameters of pH[4] and algae (ODEQ 1998). The "beneficial uses" for Diamond Lake that are currently negatively impacted by these water quality exceedances include: resident fish and aquatic life, water contact recreation, aesthetics, and fishing (OAR 340-41-0282).

Annual monitoring data by ODEQ and others demonstrates that pH values exceeded standards[5] during the summer season every year from 1992-2002. Similarly, annual monitoring data from 1992-2002 indicate that State standards for algae[6] are not being met at Diamond Lake (JC Headwaters 2003). In the summers of 2001 2002, and 2003, Diamond Lake experienced severe blooms of the cyanobacteria (blue-green "algae") *Anabaena flos-aquae.* This type of algae produces a neurotoxin that in high

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[2] Tui chub are fish in the minnow family that are not native to Diamond Lake.

[3] Approximately 95% of fish sampled in Diamond Lake in August 2002 were tui chub; this estimate does not include the large number of young-of-the-year tui chub less than 2 cm in length (Eilers and Gubala 2003). It is believed that the tui chub population is negatively impacting water quality at Diamond Lake through its impacts on the aquatic food chain. Diamond Lake has experienced a loss of large zooplankton species over the last decade (Eilers and Kann 2002). Tui chub eat zooplankton. Large zooplankton eat phytoplankton, such as the blue green "algae" *Anabaena flos-aquae* which "bloomed" at Diamond Lake in 2001,2002,& 2003. It is believed that the expanding tui chub population has "overgrazed" large zooplankton species in Diamond Lake and effectively eliminated the "biological control" that previously limited these algae populations (Eilers et al. 2001). This concept will be discussed in detail later in this document.

[4] pH is a measure of acidity and alkalinity of a solution. A pH of 7.0 is a neutral solution. The pH of natural waters ranges between the extremes of 2 to 12 with 2 being the most acidic and 12 being the most alkaline or basic (Wetzel 1983) .

[5] The applicable water body specific pH standard for Cascades Lakes is 6.0 to 8.5 (OAR 340-41-0285(2)(d)(C)). Early water quality data indicate pH values exceeded this standard for most of the 1970's as well, probably due to the high densities of aquatic macrophytes (algae and aquatic plants) (JC Headwaters 2003).

[6] Development of fungi or other growths having a deleterious effect on stream bottoms, fish or other aquatic life, or which are injurious to health, recreation, or industry shall not be allowed (OAR 340-41-0285(2)(h)). A three-month (summer) average chlorophyll *a* value exceeding 0.01 mg/l (for natural lakes) shall be used to identify water bodies where phytoplankton (floating algae) may impair recognized beneficial uses (OAR 340-41-150(a)).

concentrations is harmful to humans and other animals[7]. Another species of blue-green algae, *Microcystis aeruginosa,* was also present in the 2003 bloom. This species produces hepatotoxins which are also a health risk. To protect public health and safety, the Umpqua National Forest, in cooperation with the Douglas County Health Department, closed Diamond Lake to some public uses (wading, swimming, water skiing, and boating) during portions of all summers. Changes in lake ecology associated with overpopulation of the lake by tui chub are believed to be major contributing factors influencing the development of toxic algae blooms at Diamond Lake[8].

Diamond Lake is identified in the LRMP as a special management area (MA-2). As such, the lake is to be managed for concentrated developed recreation, favoring activities such as resort use, camping, picnicking, visitor information services, boating, fishing, interpretation and developed and dispersed winter sports (LRMP 1990, pgs. 110, 153). Summer-time lake closures which occurred during 2001 and 2002 due to degraded water quality are not compatible with MA-2 goals, are disappointing to some summer recreationists, and have negative economic impacts to some local businesses.

The desired condition for Diamond Lake is water quality that supports the beneficial uses of the lake and meets MA-2 goals. The existing water quality conditions do not meet State standards, do not support beneficial uses of the lake, and do not meet recreation management goals. Therefore, there is a need for improvement of water quality at Diamond Lake.

Measures

Quantitative and qualitative models will be used to characterize physical, chemical, and biological processes in Diamond Lake using past water quality data. Modeling results will be used to predict future water quality conditions in Diamond Lake under each alternative. Water quality improvement would be demonstrated post-project by movement toward the following water quality goals:

> pH: Less than 10 percent of summer water samples have pH values that exceed 8.5 (or the pH value determined attainable in the Total Maximum Daily Load (TMDL) calculations).
>
> Algae: The average value of primary production[9] (chlorophyll *a*[10]) for all samples collected during a three month summer sampling period is less than or equal to 0.01 mg/l (or the level determined attainable in the TMDL calculations).

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[7] Human health guidance levels derived from Yoo et al. (1995) and Chorus and Bartram (1999) indicate that when quantities of *Anabeana flos-aquae* contained in water samples reach 15,000 cells/ml it is appropriate to restrict public access for water contact recreation. Quantities of *Anabeana flos-aquae* reached approximately 600,000 cells/ml in 2001; 35,974 cells/ml in 2002; and 255,567 cells/ml in 2003.

[8] Eilers et al. (2001a,b) showed a strong correlation between historical changes in the lake and changes in the fisheries. In particular, the greatest increases in *Anabaena* akinetes (spore-like structures produced by this algae) were associated with increases in the tui chub population in both the 1940s/1950s and the 1990s.

[9] Primary production is the quantity of new organic material created by photosynthesis, or the stored energy this material represents.

Neurotoxin production: *Anabeana flos-aquae* levels remain below 15,000 cells/ml indicating that the waters of Diamond Lake are safe for water contact recreation.

Element 2 - Recreational Fishery

The Diamond Lake recreational fishery does not currently meet State management objectives or LRMP Management Area goals. For several decades, Diamond Lake has supported a large and popular recreational trout fishery that is important to the local and regional economy. No natural trout reproduction occurs in the lake, so the Oregon Department of Fish and Wildlife (ODFW) traditionally maintained the fishery in a cost-effective manner, primarily by stocking the lake each year with about 400,000 fingerling rainbow trout.

In recent years, the recreational fishery at Diamond Lake has declined dramatically from a high annual average harvest rate of about 270,000 trout averaging approximately 12 inches in size during the 1963-1978 time period to a 1999 low annual harvest rate of 5,000 trout averaging less than 10 inches in length (ODFW, Unpublished Creel Data). Failure of the formerly successful recreational fishery is attributed largely to changes in the ecology of the lake caused by overpopulation by tui chub (Eilers et al. 2001a; ODFW 2002).

The desired condition for the recreational fishery at Diamond Lake as described in applicable State regulations[11] is:

> Diamond Lake shall be managed for hatchery production under the basic yield alternative of Oregon's Trout Plan (OAR 635-500-0703), which in summary states that the waters use their natural productivity to grow trout to a harvestable size with or without the addition of fingerling or yearly hatchery trout (OAR 635-500-0115).

Specific fish stocking strategies and harvest goals associated with these regulations are generated through an adaptive management process[12]. Appropriate numeric goals for out-year stocking would be determined by ODFW using existing data and knowledge, ecological indices of lake health (i.e., zooplankton[13] and benthic invertebrate[14]

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[10] Chlorophyll *a:* Chlorophyll is the green pigment in plants. Chlorophyll *a* is the "master pigment" in blue-green algae and higher plants that is responsible for photosynthesis. It is often used as a surrogate measure for the amount of phytoplankton (microscopic floating plants-algae, diatoms, etc) in a water sample (Mandaville 1997).

[11] Relevant Oregon Administrative Rules are reproduced in the glossary.

[12] An adaptive management process refers to the practice of implementing a management strategy, monitoring the results, and then adapting the strategy as needed before implementing again.

[13] Zooplankton are very small animals that are suspended in the water column . Freshwater zooplankton are dominated by four major groups: protozoa, rotifers, and two subclasses of Crustacea, the cladocerans and copepods (Mandaville 1997). The larger zooplankton (cladocerans and copepods) are important sources of food for many species of fish.

[14] Benthic invertebrates are invertebrate organisms such as worms, leeches, and snails that live in or on the sediments at the bottom of the lake (Mandaville 1997).

populations), annual fish monitoring data and applicable nutrient loading allocations provided in ODEQ's pending TMDL publication.

LRMP MA-2 goals for the Diamond Lake fishery are general in nature and simply identify that fishing is a recreational activity that should be supported through management activities at the lake (LRMP 1990, pgs. 110, 153). Many members of the public have expressed dissatisfaction with the current recreational fishing opportunities at Diamond Lake (Personal observation, Sherri L. Chambers, 2003 Early Public Involvement Process).

The desired condition for Diamond Lake is an ecologically sustainable[15] recreational fishery that meets State standards and LRMP MA-2 goals. The existing fishery does not meet State standards and does not meet recreation management goals. Therefore, there is a need for improvement of the recreational fishery at Diamond Lake.

Measures

Because overpopulation of the lake by tui chub is believed to be the primary limiting factor in managing Diamond Lake for an ecologically sustainable recreational fishery, elimination or reduction of the tui chub population will be used as a predictive measure of progress toward the desired future condition. Scientific research and professional judgment will be used to predict and evaluate changes in tui chub populations under each alternative.

Improvement of the recreational fishery would be demonstrated post-project by movement toward the following goals:

> Ecological Indices of Lake Health: Monitoring data (zooplankton and benthic invertebrate population numbers and community compositions, and appropriate water quality data) indicate recovery of the Diamond Lake food chain is adequate to support a recreational fishery without compromising progress toward achieving water quality standards.
>
> Tui chub: Tui chub are absent from Diamond Lake or if illegally reintroduced are present in numbers believed small enough to control using limited mechanical methods (nets, seines[16], disruption of breeding, etc) or stocking with predacious fish.
>
> Trout: Annual harvest rates for legal-sized trout increase. Trout growth rates and condition factors return to levels approaching those observed prior to the introduction of tui chub.

[15] An ecologically sustainable fishery refers to the concept that fish stocking would be based on ecological indices such as phytoplankton, zooplankton, benthic invertebrate populations, and applicable nutrient loading factors.
[16] Seines are a type of fishing net that usually hang vertically in the water.

PROPOSED ACTION

The Umpqua National Forest, in cooperation with multiple state and federal agencies, proposes to implement a series of actions that will meet the need for improvement of water quality and the recreational fishery at Diamond Lake. Proposed activities include: canal reconstruction, a fall/winter lake draw down, mechanical fish removal and utilization, a September rotenone (fish toxicant) treatment to eradicate tui chub, fish carcass removal and utilization, water management during lake refill period, monitoring, fish restocking, educational activities, and contingency measures for controlling tui chub if they are reintroduced to Diamond Lake in the future. Proposed activities are described in detail below in the order in which they would be implemented:

Canal Reconstruction

There is an existing earthen canal (ditch) in the northwest corner of Diamond Lake adjacent to Lake Creek. In its original condition, this canal was used to lower Diamond Lake prior to the rotenone treatment that occurred in 1954. The canal extends approximately 300 yards from the lakeshore southward into Diamond Lake. The canal is interrupted or filled in at the Dellenback Bike Trail and US Forest Service Road 4795 crossings, but continues northward, parallel to Lake Creek for about 350 yards before it terminates next to Lake Creek. The canal has not been used since about 1954 and soil, debris, and aquatic plants have partially filled the canal, thereby reducing its flow capacity.

This project would reconfigure the existing canal to its original dimensions. From the lakeshore to the canal outlet into Lake Creek, the canal would be excavated to its original configuration. The reconstructed canal would be a native surface (soil and bedrock) channel with a head-gate structure to control flow of water from the lake. Specific actions necessary to accomplish this would include: 1) removal of the fill from the bike trail and Road 4795 where they cross the canal, 2) removal of the existing headgate water control structure, 3) reshaping the canal to its original dimensions, 4) installing a new headgate water control structure, and 5) if necessary, construction of new bridges or culverts to maintain access to the bike trail and summer cabins. Excavated material would be placed in an approved location where there is no risk of erosion. The headgate water control structure on Lake Creek would also be rebuilt or replaced.

From the lakeshore into the lake (to the original canal initiation point), the canal would be dredged to its original depth and configuration. Specific actions associated with this portion of the project would include: 1) Removal of material from the existing canal using a floating suction dredge, and 2) Utilizing the dredge spoils to expand an existing wetland located within the northwest corner of the lake. Dredge spoils (approximately 1500 cubic yards) would be pumped into an area adjacent to an existing wetland that would be fenced off using silt fence. This fence would keep the dredge spoils in place until wetland vegetation colonizes and stabilizes the site. Following this, the fence would be removed.

Fall/Winter Lake Draw Down

Using both the reconstructed canal and Lake Creek for water transport, this project would lower the water level in Diamond Lake by eight feet from its normal summer level[17]. The lake draw down would begin on or around September 15th in the year prior to chemical treatment. A gravity-driven draw down would occur at a discharge rate approximating a bankfull[18] flow in Lake Creek (roughly 110 cubic feet per second). The total volume of water removed from the lake would be approximately 20,100 acre-feet[19].

The draw down would be accomplished as follows: 1) At the beginning of the draw down, over a period of seven days, flows within Lake Creek would be gradually increased to a bankfull flow level, 2) Once a bankfull flow is achieved, this flow level would be maintained until the lake level reached the desired eight foot reduction, and 3) Only naturally induced storm flows (from large rain events) would be allowed to exceed the bankfull flow. The speed at which the lake drains is highly dependant upon the weather patterns for that given year. Therefore, predicting the exact date when the draw down would be complete is impossible. However, the target date for achieving the 8 foot draw down is April 1st in the year of treatment. Once the desired level is achieved, it would be maintained throughout the summer and fall of that year.

This lake draw down would accomplish multiple objectives:

- The draw down would temporarily de-water the marshes at Silent Creek and the northwest end of the lake, leaving only open water to be chemically treated, thereby increasing the likelihood of a complete fish kill.
- The draw down would concentrate the fish population and reduce the total amount of rotenone needed.
- The draw down would temporarily dry up the Lake Creek outlet, preventing rotenone treated waters from flowing downstream into the North Umpqua River subbasin.
- Timing the draw down in the fall and winter months would minimize potential downstream nutrient and other water quality affects associated with transporting additional lake water through the system.
- Designing the draw down to occur in the fall and winter months would allow for the lake to be lowered by the desired eight feet prior to the onset of higher spring snowmelt flows. During spring snowmelt, runoff would flow out the canal and into Lake Creek under the naturally occurring flow regime.

PacifiCorp would be notified in advance of canal opening and closure and would adjust their water schedules accordingly. Temporary docks or boat ramp extensions (described

[17] Normal summer water level refers to the midsummer maximum pool level (about 68,100 acre -feet) with boards regulating water flow from Diamond Lake into Lake Creek. ODFW has existing water rights that allow them to raise the water level in Diamond Lake by placing wooden boards across the Lake Creek outlet.
[18] In general terms, the bankfull stage refers to the stream flow that just fills the channel to the top of its banks and at a point where the water begins to overflow onto a floodplain (Rosgen 1996).
[19] An acre-foot is equivalent to a volume of water 1 foot deep over 1 acre of land (Viessman and Lewis 1996).

in detail in the rotenone treatment section) would be installed to facilitate boat access to the lake following the draw down.

Mechanical Fish Removal and Utilization

Several methods would be used to reduce fish biomass in Diamond Lake prior to a chemical treatment:

- During the year of a chemical treatment, the Oregon Department of Fish and Wildlife (ODFW) would not stock Diamond Lake and would liberalize catch limits on fishing.
- During the spring/summer prior to a chemical treatment, ODFW crews would use nets and seines to harvest fish from the lake.
- For approximately one to four weeks in the summer or early fall prior to a chemical treatment, professional commercial fishing operations would be used to harvest fish from the lake. Fish carcasses would be converted to an organic fish emulsion product on site (lake shore) or trucked to an off-site plant for utilization as fertilizer.

The objective of live fish removal would be to reduce the quantity of fish biomass available for conversion into nutrients following a chemical treatment.[20] Recycling of fish as fertilizer would reduce waste and the necessity to utilize landfills.

September Rotenone Treatment

The powdered formulation of the fish toxicant rotenone (Pro-Noxfish®) would be applied to Diamond Lake in September when water temperature and chemistry reached conditions considered optimal for achieving a complete fish kill. Rotenone would be administered according to label instructions at the necessary amounts based on water volume, temperature, and chemistry in Diamond Lake at the time of application.

To determine the minimum appropriate rotenone concentration levels, prior to application, site-specific bioassay tests[21] would be conducted on tui chub utilizing rotenone from the stock to be used in lake treatment and water from Diamond Lake. However, in general, according to current recommended application rates, a minimum and maximum range of active rotenone concentration of 0.025 and 0.10 parts per million (ppm) would be needed to achieve the treatment goal (Finlayson et al. 2000).

For example, based on a predicted water volume of 48,000 acre-feet following the drawn down, mean temperature and pH observed in Diamond Lake in September, and a mean

[20] Although mechanical removal of fish carcasses following a rotenone treatment is proposed, it is expected that some fish would sink to the bottom and would not be retrieved ("sinkers"). These carcasses would contribute to nutrient loading in Diamond Lake. Removal of fish prior to treatment would reduce the number and biomass of potential "sinkers" and thus reduce potential nutrient loads.

[21] A bioassay is a common laboratory test used to determine toxic levels of substances for a given species (Royce 1984).

active rotenone concentration of 0.05 ppm[22], it is estimated that about 130,000 pounds of rotenone would be needed to eradicate the tui chub population.

All of the following detailed plans would be completed according to recommendations and examples provided in the "Rotenone Use in Fisheries Management: Administrative and Technical Guidelines Manual" prior to project implementation: rotenone application plan, site safety plan, site security plan, and a spill contingency plan (Finlayson et al. 2000). However, in general, handling and application of rotenone would be accomplished as follows.

> After September 1 in the year of treatment, rotenone would be transported by truck directly to the Diamond Lake site via State Highway 97. Rotenone would be stored at three operational sites: the north end dock facilities, Mt. Thielsen Campground and Broken Arrow Campground. Security would be provided 24 hours/day at each site while rotenone is present on site. Rotenone would be stored in the delivery trucks. Enough potassium permanganate (rotenone neutralizer) to neutralize the largest container of rotenone would also be stored on site.
>
> Temporary docks would be needed at all three operational sites to facilitate loading rotenone onto boats or barges. National Guard temporary bridge facilities or ribbon bridges[23] would be used as temporary docks, if available. If these structures are not available, then the existing boat ramps would be extended by constructing a gravel "road" to allow the use of loading booms to move rotenone containers onto barges.
>
> Certified pesticide applicators would be responsible for all phases of rotenone application. Outlets would be closed and locked using control gates so treated water would not escape down the reconstructed canal or Lake Creek. Diamond Lake would be closed to the public during rotenone application and reopened when safety concerns were eliminated. Application of rotenone to Diamond Lake proper would be conducted systematically from boats and/or barges using high-pressure pumps and emulsification techniques similar to those used in mixing fire retardant. Treatment of the lake would take one to three days.
>
> Concurrently, due to the potential presence of tui chub in these areas, sections of the two major inlet streams to Diamond Lake, Silent Creek and Short Creek, would be treated with rotenone. Because the lake level would be drawn down prior to application, only sections of the streams located at or below normal summer lake level would be treated. The liquid rotenone formulation Noxfish®[24]

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[22] This treatment concentration would be met by applying 1 ppm of the Pro-Noxfish rotenone formulation (Finlayson et al. 2000).

[23] Ribbon bridges are bridges created by placing sections of tread together on a floating pontoon.

[24] Finlayson et al. (2000) state that liquid rotenone is the only effective formulation of rotenone for treating flowing waters. Noxfish® is the recommended liquid rotenone product for use at Diamond Lake because it *does not* contain Piperonyl Butoxide, an additive in some liquid products that may persist in treated water for several months.

would be used at an active rotenone concentration level of about 0.10 ppm [25]. Rotenone would be applied at drip stations along the stream channels. Drip stations would be operated for approximately 17 days and would use approximately 375 gallons of liquid rotenone. Impassable barriers to upstream movement by tui chub would be constructed in these creeks and other smaller inlets during the lake draw down period. These barriers would prevent fish from escaping above the treatment area prior to and during the application of rotenone.

Diamond Lake outlets (Lake Creek and reconstructed canal) would remain closed until tests indicated that rotenone, rotenolone[26], and all semi-volatile and volatile organic compounds[27] associated with the chemical treatment had dissipated to non-detectable or trace levels in both the water column and lake bottom sediments (approximately one to two months).

Mechanical Fish Carcass Removal & Utilization

A commercial fishing or professional fish mortality recovery and recycling operation would be employed to collect fish carcasses as soon as logistically feasible following a chemical treatment of the lake. Harvested fish carcasses would be converted to an organic fish emulsion product through on-site processing and then trucked off-site, or carcasses would be trucked to an off-site plant for utilization as fertilizer.

Removal and utilization of fish carcasses would accomplish multiple objectives:

- A reduction in the level of nutrients (from decaying fish) that would be added to Diamond Lake and later transported downstream.
- A reduction in the negative aesthetic impacts (visual and odor) associated with large quantities of accumulated dead fish.
- A reduction in the waste and environmental impacts associated with disposal of large quantities of fish into a landfill.

Water Management During Lake Refill Period

As Diamond Lake begins refilling, the following water management strategy would be implemented to limit the length of time that Lake Creek is reduced to no or very low flows. When water in Diamond Lake becomes suitable for release (about November), canal headgates would be opened to allow approximately 10 cubic feet per second (cfs)

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[25] Very cold streams like Silent and Short Creek require utilization of higher concentrations of rotenone to effectively kill fish.

[26] Rotenolone is the metabolite (by product) of rotenone (Finlayson et al. 2000).

[27] The liquid rotenone formulation Noxfish® contains inert emulsifiers, solvents, and carriers that are important in ensuring the solubility and dispersion of rotenone in water. Waters treated with Noxfish® may contain rotenone, rotenolone, and volatile (xylene, trichlorethylene, toluene, and trimethylbenzene) and semi-volatile (naphthalene, 1-methyl naphthalene, and 2-methyl naphthalene) organic compounds. These volatile and semi-volatile organic compounds dissipate in treated water before rotenone and rotenolone (Finlayson et al. 2000).

of water to flow into Lake Creek and through the North Umpqua River system. The outlet would be periodically adjusted to maintain this flow as Diamond Lake refills with inflow exceeding the 10 cfs outflow. The rate of refill would depend largely on precipitation patterns during the refill period, but could be complete by the following summer. Once the lake level reaches the Lake Creek outlet, the canal would be closed and surface flow through the Lake Creek outlet would be restored. As during the draw down, PacifiCorp would be consulted prior to any flow changes so that they could schedule the routing of water through Lemolo Lake during the refill period.

It is recognized that during the year of treatment, ODFW would be unable to store water in Diamond Lake to satisfy their downstream water right. Thus, if treatment occurred during a dry year, the Rock Creek Hatchery summer water supply could be compromised. PacifiCorp would coordinate with ODFW to route water as efficiently as possible during this time.

Monitoring

A variety of monitoring activities would occur before, during and after project implementation. Monitoring results would be used to verify assumptions, evaluate project success, and formulate appropriate lake management strategies utilizing an adaptive management process. Proposed monitoring activities and general timeframes include, but are not limited to:

- Stream flows, channel morphology, and water quality in Lake Creek would be monitored periodically throughout all phases of project implementation and post-project.
- Water quality in Lemolo Lake and the North Umpqua River would be monitored periodically throughout all phases of project implementation and post-project.
- Diamond Lake water quality would be monitored for a minimum of five years[28] post-project.
- Phytoplankton, zooplankton and benthic invertebrate populations would be monitored for a minimum of five years[28] post-project.
- Extensive monitoring for tui chub presence in Diamond Lake would be conducted for a minimum of five years[28] post-project.
- Trout populations and annual harvest rates would be monitored for a minimum of five years[28] post-project.

Fish Restocking Strategy

ODFW would pursue approval for a change to the following strategy for restocking Diamond Lake with fish through the Oregon Fish and Wildlife Commission (OFC) and the appropriate public process. ODFW would utilize monitoring data and adaptive

[28] A five year minimum time period is referenced because this represents the normal lifetime of an EIS. However, it is anticipated that this monitoring will occur well beyond five years.

management to determine an ecologically appropriate fish stocking strategy for Diamond Lake for the years following a rotenone treatment. In general, Diamond Lake would be managed for hatchery production under the basic yield alternative of Oregon's Trout Plan (OAR 635-500-0703 and OAR 635-500-0115). However, appropriate numeric goals for annual fish stocking and harvest post-project would be determined by ODFW using existing data and knowledge, ecological indices of lake health (i.e., zooplankton and benthic invertebrate populations), annual fish monitoring data and applicable nutrient loading allocations provided in ODEQ's pending TMDL publication.

Under this stocking strategy, it is expected that conservatively small numbers of fingerling "Fishwich"[29] or Oak Springs rainbow trout and trophy and/or legal sized predacious fish species (Eagle Lake rainbow trout, brown trout, or spring Chinook) would be introduced into Diamond Lake as soon as the food chain recovered adequately to support them without compromising progress toward water quality goals. Annual stocking rates would be expected to increase as the food chain and water quality continued to recover. ODFW would develop a new implementation plan for management of the Diamond Lake fishery when sufficient monitoring data becomes available to predict ecologically sustainable stocking levels.

Education

A number of educational measures would be considered for implementation to reduce the likelihood of tui chub reintroduction into Diamond Lake, including but not limited to:

- A required "angler stamp" for persons desiring to fish at Diamond Lake. Stamps would be free to the public (or low cost) and would come with an educational brochure documenting the ecological and economic costs associated with the past introduction of the tui chub into Diamond Lake.
- Interpretive signs documenting the history of the tui chub at Diamond Lake.
- Distribution of interpretive brochures to campers and visitors.
- Boat inspections to detect presence of tui chub in live wells or occurrence of aquatic weeds that could contain viable tui chub eggs (or other invasive organisms). Distribution of educational messages and materials during inspections.
- Interpretive signs and brochures at Lemolo Lake describing recommended or required practices for boaters moving from Lemolo to Diamond Lake (i.e. boat cleaning).

Tui Chub Contingency Plan

Because it is recognized that tui chub may be illegally reintroduced into Diamond Lake, several actions designed to control tui chub populations would be implemented:

[29] Native rainbow trout strain; the brood stock for these fish was collected from rainbow trout in two upper North Umpqua River tributaries- Mowich and Fish Creeks.

- An extensive monitoring program would be conducted to facilitate early detection of tui chub presence in the lake. Population control measures are more likely to be effective if there are low numbers of tui chub present.
- ODFW plans to stock Diamond Lake with predacious fish species following a rotenone treatment. These fish would be present in the lake to prey upon chub. If tui chub were detected in the lake, ODFW would substantially modify their stocking strategy to include more predacious fish.
- Mechanical treatments including, but not limited to: netting, seining, trapping, electro shocking, and disruption of spawning would be used to limit tui chub population growth.

ALTERNATIVES:

ALTERNATIVE 1 (No Action): This alternative serves as the baseline for estimating environmental effects of the action alternatives. No canal reconstruction, lake draw down, mechanical fish harvest, chemical treatment, fish carcass removal, or lake refill would occur. No active measures to improve water quality at Diamond Lake would be implemented. Potentially harmful algae blooms and lake closures would be expected to continue.

ODFW would continue with the existing experimental fish stocking program (100,000 fish) in 2004 and 2005. In 2006, ODFW and the Oregon Fish and Wildlife Commission (OFWC) would revisit the Diamond Lake Fishery Management Plan to determine appropriate stocking. Based on current knowledge and budget, it is expected that ODFW would stock Diamond Lake with 24,000 legal sized rainbow trout on annual basis in 2006 and beyond.

ALTERNATIVE 2 (Proposed Action) – Described above

ALTERNATIVE 3 – (Put and Take Fishery): Alternative 3 responds to the fish stocking issue. This alternative is designed to provide a "good"[30] recreational fishery that minimizes potential effects of fish on water quality in Diamond Lake. Alternative 3 is identical to the proposed action except that it would utilize a different fish stocking strategy to restock Diamond Lake following a rotenone treatment.

Alternative 3 includes all of the following components of the proposed action described in Alternative 2***: canal reconstruction, fall/winter lake draw down, mechanical fish removal and utilization, rotenone treatment, mechanical fish carcass removal and utilization, water management during the lake refill period, monitoring, education, and a tui chub contingency plan***.

Additionally, under this alternative***, ODFW would pursue approval for a change to the following strategy for restocking Diamond Lake with fish through the OFWC and the appropriate public process.***

[30] In general, a "good" recreational fishery represents a substantial improvement over the current fishery, but would not be expected to achieve the status of an "excellent" fishery such as existed at Diamond Lake during its previous peak period as a recreational fishery.

If approved by OFWC, management of the Diamond Lake recreational fishery would change from a Basic Yield Alternative under Oregon's Trout Plan (OAR 635-500-0703 and OAR 635-500-0115(4)) to an Intensive Use Alternative (OAR 635-500-0115(5))[31]. In layman's terms this is a "put and take fishery" where legal sized fish are stocked in the spring and are harvested by anglers later in the same season.

Under this stocking strategy, it is estimated that ODFW would stock Diamond Lake annually with up to 400,000 8-10" domesticated rainbow trout. Trout from this brood stock would not reproduce successfully in Diamond Lake, would not prey significantly on available food organisms, and the majority would not survive over winter. Diamond Lake would be stocked with domesticated trout in late spring following a fall rotenone treatment (since these fish would not require a robust existing food base). Stocking would occur periodically from late spring to early fall on an annual basis.

Subsequently, as part of the "tui chub contingency plan", legal or trophy sized predacious fish species (Eagle Lake rainbow trout, brown trout, or spring Chinook) would be introduced into Diamond Lake as soon as the food base recovered adequately to support them without compromising progress toward water quality goals. Ecological indices of lake health (i.e., zooplankton and benthic invertebrate populations), existing data and knowledge, annual fish monitoring data and applicable nutrient loading allocations provided in ODEQ's pending Total Maximum Daily Load (TMDL) publication would be used to determine appropriate numeric goals for all annual fish stocking and harvest post-project.

Connected Actions: Connected actions by the Diamond Lake Resort are the same as those described in Alternative 2.

ALTERNATIVE 4 – (Mechanical/Biological): Alternative 4 responds to the issues of fish stocking, non-target species, water quality, and wetland ecology. This alternative is designed to minimize effects of a chemical treatment and associated lake draw down on resources while limiting/controlling the tui chub population. This alternative does not include a lake draw down so potential impacts to water quality and wetland ecology from a draw down are eliminated; and does not include a chemical treatment so potential impacts to non-target species and water quality from chemicals are eliminated. This alternative includes a modified fish stocking strategy designed to reduce the potential impacts of a recreational fishery on water quality in Diamond Lake.

Alternative 4 would use mechanical techniques in combination with predacious fish stocking to selectively harvest chub, disrupt chub spawning and increase predation on chub, with the objective of severely diminishing chub populations over time. Alternative

[31] Intensive Use--"….Waters managed for this alternative are apt to be near large population centers or attract intensive angler use because of easy accessibility or location of other water-oriented recreational facilities. Many of these waters support fisheries year-round. Many of these waters can be used heavily by anglers or for short periods (April, May, and June) and afterwards be used for sailboating, water skiing, swimming, and camping. Other waters can support fisheries year-round. Some of these waters are stocked with yearling rainbow trout on a regular basis. Guidelines which apply are:…." (OAR 635-500-0115(5).)

4 includes the following components of the proposed action described in Alternative 2: ***education*** and ***monitoring***. Additionally, this alternative includes all of the following components:

Annual Mechanical Harvest: Mechanical fish harvest treatments would occur on an annual basis for six consecutive years utilizing a variety of commercial fishing tools/techniques determined to be most effective through an adaptive management process. Potential tools include: seine nets, trawl nets, cast nets, gill nets, lampara[32] and beach seines, custom-built traps, or other types of commercial nets, seines, and traps. Fish harvest activities would likely occur for two months in June and July prior to and during the chub spawning period at Diamond Lake. Commercial fishing operations would only occur in certain portions of the lake at a given point in time and would be rotated to different portions of the lake during the two month period. Areas where commercial fishing was occurring would be closed to recreational angling. Commercial fishing would also occur annually for approximately one month in September in an effort to harvest chub as they move from the shallows into more open water within the lake. Mechanical fish harvest treatments would target reproductive age chub. The goal of these activities would be to harvest 85-95%[33] of the reproductive-age chub annually, while attempting to maintain a biological control (predacious fish) on the tui chub population. It is expected that annual commercial fishing operations described above would be needed to effectively limit tui chub recruitment in Diamond Lake over time.

Contingent on available funding, ODFW would pursue approval from OFWC for the establishment of a bounty on tui chub at Diamond Lake. A bounty would be used as a supplementary tool to remove tui chub from the lake while informing the public about the chubs' role in the declining health of Diamond Lake.

Spawning Disruption: In addition to the above activities, electro fishing boats would be used during the peak chub spawning period to disrupt spawning in the shallow areas of the lake that have abundant aquatic macrophytes.

Predacious Fish Stocking**: **ODFW would pursue approval for a change to the following strategy for restocking Diamond Lake with fish through the OFWC and the appropriate public process. In general, Diamond Lake would be stocked annually with large predacious fish in sufficient numbers and of sufficient size/age classes to serve as potentially effective predators on the tui chub as well as to provide a recreational fishery. Specifically, if approved by OFWC, management of the Diamond Lake recreational fishery would change from a Basic Yield Alternative under Oregon's Trout Plan (OAR

[32] A lampara net is a type of open water seine with tapered ends and a relatively deep, loosely hung center section. The net is set in a circle around the fish school and the two ends are brought together capturing the fish in the middle (Nielsen and Johnson 1989)

[33] Rationale and supporting documentation for the 85-95% are provided in Appendix *.

635-500-0703 and OAR 635-500-0115(4)) to either a Featured Species[34] (OAR 635-500-0115(2)) or Trophy Fish Alternative[35] (OAR 635-500-0115(3)).

OAR 635-500-0115(4)(b) under the Basic Yield Alternative states: "The productive capacity of the waters in this alternative will be maintained or enhanced so that no net loss of natural fish production occurs. Problem waters[36] can be transferred into a higher priority alternative." Both the "Featured Species" and "Trophy Fish" alternatives are higher priority alternatives in the Oregon Trout Plan.

A Featured Species stocking strategy would include annual stocking with legal and/or trophy sized Eagle Lake rainbow trout. A Trophy Fish stocking strategy would include annual stocking with legal and/or trophy sized brown trout or Kamloops rainbow trout. Special angler harvest regulations to protect large trout would be considered. Ecological indices of lake health(i.e., zooplankton and benthic invertebrate populations), existing data and knowledge, annual fish monitoring data and applicable nutrient loading allocations provided in ODEQ's pending Total Maximum Daily Load (TMDL) publication would be used to determine appropriate numeric goals for annual fish stocking and harvest post-project.

III. Other Requirements

In accordance with the June 5, 1998 guidance (OR-98-264), additional documentation is needed to clearly address project consistency with objectives of the Aquatic Conservation Strategy (ACS); recommendations from Watershed Analysis (WA); and conservation recommendations, reasonable and prudent measures, and terms and conditions of the National Marine Fisheries Service March 18, 1997, plan-level Biological Opinion (BO). The following information and analysis serves two purposes: 1) to supplement the existing information in the project-level EIS and 2) clearly document the logic tracking and links of the project with WA, the ACS, and the plan-level BO.

Compatibility with Aquatic Conservation Strategy and other Initiatives

The four components of the Aquatic Conservation Strategy are 1) Riparian Reserves, 2) Key Watersheds, 3) Watershed Analysis, and 4) Watershed Restoration.

1. Through watershed analysis, Riparian Reserves have been determined and established for the watersheds in the analysis area.
2. There are no Key Watersheds in close proximity to the Diamond Lake Restoration Project Area. The nearest Key Watersheds are located more than 33 miles downstream, below Soda Springs Dam. All of these Key Watersheds

[34] "Featured Species and Waters—Management under this alternative emphasizes species or stocks that are uncommon or unique and waters that have historical benefit or potential for unique natural beauty, water quality, aesthetics or recreational capabilities…" (OAR 635-500-0115(2))
[35] "Trophy Fish—Certain waters are capable of producing large "bragging-size" trout …"(OAR 635-500-0115(3))
[36] Problem waters are not defined in the OARS however, according to ODFW personnel, the degraded water quality at Diamond Lake qualifies it as"problem water".

are tributaries of the main stem North Umpqua River, and would not be impacted by this proposed project. These watersheds include Boulder Creek, Copeland Creek, Deception Creek/Wilson Creek, Calf Creek, and Steamboat Creek.

3. The Diamond Lake/Lemolo Lake Watershed Analysis was completed in 1998. The Upper North Umpqua Watershed Analysis was completed in 1997. The Middle North Umpqua Watershed Analysis was completed in 2001.
4. Numerous watershed restoration activities have been conducted throughout the North Umpqua River sub-basin. One of the primary intents of this project is to help restore water quality in Diamond Lake and downstream.

An evaluation of the project's consistency with ACS objectives is contained in the aquatic portion of the Diamond Lake Restoration Project DEIS.

Consistency with Watershed Analysis

The *Diamond Lake/Lemolo Lake Watershed Analysis, the Upper North Umpqua Watershed Analysis,* and *the Middle North Umpqua Watershed Analysis* identify general physical, biological, and historical processes affecting the landscape. These analyses describe management objectives and recommendations for upland and aquatic management and restoration.

In the Diamond Lake/Lemolo Lake document, there are no specific recommendations pertaining to restoration of Diamond Lake. At the time the document was written, it was assumed that Diamond Lake would be treated with rotenone to eliminate tui chub and restore water quality. The same is true for the Upper North Umpqua analysis. The Middle North Umpqua analysis contains recommendations specific to the main river corridor, but no recommendations pertaining to upstream activities. The proposed project would be consistent with all analyses.

Consistency with Northwest Forest Plan S & Gs

The Record of Decision for the Northwest Forest Plan contains standards and guidelines (S&Gs) designed to reduce the impacts of ***Watershed and Habitat Restoration*** activities, as well as ***Fish and Wildlife Management*** activities, on aquatic organisms. All of these S & Gs were reviewed, and applied to the proposed action as appropriate. Specifically, the proposed action meets the following ***Watershed and Habitat Restoration*** S&G's:

WR-1 –Design and implement watershed restoration projects in a manner that promotes long-term ecological integrity of ecosystems, conserves the genetic integrity of native species, and attains Aquatic Conservation Strategy objectives.

WR-2 – Cooperate with federal, state, local, and tribal agencies, and private landowners to develop watershed-based Coordinated Resource Management Plans or other cooperative agreements to meet Aquatic Conservation Strategy objectives.

Under ***Fish and Wildlife Management***, the following S&G's apply:

FW-1 – Design and implement fish and wildlife habitat restoration and enhancement activities in a manner that contributes to attainment of Aquatic Conservation Strategy objectives.
FW-4 – Cooperate with federal, tribal, and state fish management agencies to identify and eliminate impacts associated with habitat manipulation, fish stocking, harvest and poaching that threaten the continued existence of native fish stocks occurring on federal lands.

Evaluation of Consistency with the NMFS March 18, 1997 Plan-level BO

Conservation Recommendations

Watershed Restoration

6 - To promote long-term ecosystem recovery, actions that restore landscapes and aquatic ecosystem processes should be prioritized over instream habitat enhancement projects that provide short-term benefits. Restoration of ecosystem processes is one of the primary intents of the Diamond Lake Restoration Project. Therefore, this project is consistent with Conservation Recommendation #6.

Reasonable and Prudent Measures

During the project design and analysis of environmental consequences for the proposed action described in the DEIS, the interdisciplinary team crafted project design features and utilized Best Management Practices to ensure the proposed actions are consistent with applicable management action/direction. The management action/direction incorporates the standards and guidelines of the Record of Decision for the Northwest Forest Plan.

1. Reasonable and Prudent Measure 1 – Consistency of the project with the ACS objectives has been addressed.
2. Reasonable and Prudent Measure 2 – Relevant indicators from the Matrix of Pathways and Indicators were considered and addressed and will be submitted to NOAA/Fisheries prior to project initiation
3. Reasonable and Prudent Measure 3 – N/A
4. Reasonable and Prudent Measure 4 – Watershed analyses for each 5th field HUC were completed prior to analysis of the proposed project. In addition, one of the primary purposes of this project is to restore water quality and other ecosystem processes.
5. Reasonable and Prudent Measure 5 – All in-stream construction work planned in association with this project would be designed to minimize downstream impacts to aquatic habitat, and listed fish species downstream.
6. Reasonable and Prudent Measure 6 – Best Management Practices from the Umpqua National Forest LRMP have been incorporated into the project design
7. Reasonable and Prudent Measure 7 – Certain watershed-level environmental baseline conditions are currently in a highly degraded state (i.e. water quality). These conditions may continue to be temporarily impacted in the short term.

However, these conditions would likely improve over the long term, making the proposed action appropriate and timely.

Terms and Conditions

1. Terms and Conditions 1.a – The proposed actions are consistent with the ACS objectives and supported by the analysis in the *Diamond Lake Restoration Project DEIS*. The proposed actions would likely result in long-term improvements in aquatic ecosystem health, consistent with ACS objectives to maintain or restore watershed conditions.
2. Terms and Conditions 2.a-c –An interdisciplinary team reviewed the proposed actions and documented the anticipated consequences in the *Diamond Lake Restoration Project DEIS* . This analysis resulted in a "may affect, not likely to adversely affect" determination.
3. Terms and Conditions 7 – Based upon the continued decline in water quality conditions at Diamond Lake, this project was found to be appropriate and timely. Information taken from Watershed Analysis and project analysis was utilized to verify this.

No other Terms and Conditions contained in the NMFS March 18, 1997 Plan Level BO specifically apply to the proposed action.

Discussion of potential effects on ESA listed fish:

The activities associated with project monitoring, live fish removal and utilization, fish carcass removal and utilization, fish stocking, educational activities, and the tui chub contingency plan would have no effect on coho salmon populations found 33 miles downstream. Therefore, these project components will not be analyzed in depth here.

From a strictly geographic standpoint, the Diamond Lake Restoration Project has the potential to effect watershed conditions in four individual 5th field watersheds. From highest elevation to lowest, these 5th field watersheds include Diamond Lake, Lemolo, Upper North Umpqua, and the Middle North Umpqua (refer to Map x – In progress).

Virtually all of the potential effects to aquatic resources downstream associated with this project would be moderated and/or eliminated as a result of the development of protective Project Design Criteria (PDC's), as well as water and sediment storage, and energy dissipation provided by the three large reservoir systems associated with the Pacificorp hydropower project (Lemolo, Toketee, and Soda Springs reservoirs). For additional aquatic effects discussions, refer to the Diamond Lake Restoration DEIS.

As mentioned previously, the nearest habitat for coho salmon is located in the Middle North Umpqua 5th field below Soda Springs dam, a distance of 33 stream miles from the Diamond Lake project. Since the only potential for an effect to coho salmon or their habitat occurs in the Middle North Umpqua 5th field, only this 5th field will be analyzed in depth in this Biological Evaluation.

Since the 5th field watershed being discussed is 33 miles away from the actual Diamond Lake Restoration Project area, detailed narrative discussion of all MPI indicators was considered to be irrelevant, and not pertinent to this effects determination. Only those indicators that could be potentially impacted by the Diamond Lake Restoration Project are discussed in-depth in this document. In addition, since the Diamond Lake project would have no influence on individual 6th field sub-watersheds within the Middle North Umpqua 5th field, this baseline condition evaluation only considers the main stem North Umpqua River. If additional information is desired on a particular indicator, or 6th field sub-watershed, refer to the Middle North Umpqua Watershed Analysis.

The relative condition values listed for the indicators in Table 1 below were derived from the Middle North Umpqua Watershed Analysis (USDA, 2001), field reviews associated with other projects in the area, and best professional judgement.

Table 1. Matrix of Pathways and Indicators for the Middle North Umpqua 5th Field Watershed

Environmental Baseline				Effects of Alt. 1, 2, 3, and 4		
Relevant Indicators	**Properly Functioning**	**At Risk**	**Not Prop. Functioning**	**Restore**	**Maintain**	**Degrade**
Water Quality						
Maximum Temp			X (1,3)		All	
Sediment & Turbidity		X (1,2,3)			All	
Chemical/ Nutrients		X (3)		← Trend	All	
Habitat Elements						
Physical Barriers	X (1,3)				All	
Large Woody Material			X (1,2,3)		All	
Substrate			X (1,3)		All	
Pool Character		X (1,3)			All	
Low Velocity Refuge		X (1,3)			All	
Refugia		X (1,3)			All	
Channel Condition and Dynamics						
Width/Depth Ratio	X (1)				All	
Streambank Condition	X (1,2,3)				All	
Floodplain Connectivity		X (1,2)			All	
Flow/ Hydrology						
Changes in Peak/Base Flows			X (1,3)		All	

Environmental Baseline				Effects of Alt. 1, 2, 3, and 4		
Relevant Indicators	Properly Functioning	At Risk	Not Prop. Functioning	Restore	Maintain	Degrade
Drainage Network			X (1)		All	
Watershed Conditions						
Road Density			X (1)		All	
Disturbance History		X (1,2,3)			All	
Riparian Reserves			X (1,2,3)		All	
Landslide Rates		X (1,2)			All	

1 = Data from Surveys/Watershed Analysis
2 = Data came from field review for a project
3 = Professional Judgment

WATER QUALITY

Maximum Water Temperature: The Diamond Lake Restoration project would have no impact on maximum summer water temperatures in the North Umpqua River below Soda Springs Dam.

Sediment and Turbidity: The largest potential for streamside erosion, sediment entrainment, and turbidity increases would come during the draw down portion of the project, and would stem from three small areas of stream bank instability along Lake Creek. The majority of the sediments are of volcanic origin, and do not stay in solution for long periods of time. Based on field review of potential erosion areas in Lake Creek, as well as anecdotal accounts of the 1954 draw down, the potential for large sediment and/or turbidity increases associated with this project is low. In addition, based on Lake Creek stream gauge data, the relatively small increase in stream flows during the draw down period (~ 50 cfs), would be well within the range of natural flows that have helped form the current channel of Lake Creek over the past several decades. Therefore, any sediment and/or turbidity increases caused by draw down activities would likely be small, and would settle out in the system of reservoirs prior to reaching anadromous fish bearing waters (see the FLOW/HYDROLOGY section for additional context on the low potential for increased sediment and turbidity).

Chemical Contaminants/Nutrients: Nutrients - Alternatives 1 and 4 would result in the continued contribution of nutrient enriched waters entering Lemolo Reservoir, and ultimately the North Umpqua system. In combination with other activities in the basin (i.e. recreation, timber harvest, fertilization, hydropower activities, and others) this could contribute to a cumulative negative impact on trophic interactions in that system (ie. shifts in aquatic insect functional feeding groups). Conversely, Alternatives 2 and 3 (in combination with the cumulative activities listed above) would likely result in slight reductions of nutrient enriched waters entering Lemolo Reservoir and the North Umpqua system. This may ultimately lead to slight beneficial impacts to downstream populations of aquatic insects as elevated nutrient levels begin to decrease slightly.

The extent of the potential negative or beneficial impacts to the trophic structures downstream (from all alternatives) is likely to be relatively small when considered in context with all of the other activities in the watershed (table xx, DEIS). Therefore, it is highly unlikely that any of the alternatives would result in detectable impacts to aquatic insect populations, or fish species living in those areas.

It is highly unlikely that any of the alternatives would result in direct, indirect, or cumulative effects to fish populations in the North Umpqua River below Soda Springs Reservoir.

Chemical Contaminants - Before chemical treatment of the lake, lake outflow through the canal would be closed and the only flow in Lake Creek would be from groundwater and tributaries. A recent low flow investigation of Lake Creek (September 2003) revealed that there is little accretion of flow from groundwater or tributaries from the outlet to Sheep Creek, about 5.5 miles downstream. This segment of channel would likely have little to no flow with only some pooled water for about 2-3 months. The same investigation measured about 0.84 cfs at the mouth of Sheep Creek. The largest flow contribution to Lake Creek would be from Thielsen Creek, about 8 miles downstream of the outlet. Thielsen Creek may contribute as much as 5 cfs during this dry channel phase. The limited to no-flow condition for this 8-mile segment of Lake Creek would not change until lake water becomes safe to be released through the canal after treatment (i.e no chemicals detected). Flow would be gradually released from Diamond Lake about 2-3 months after closing the canal. The initial release would be about 10 cfs in the spring when flows historically have been 5-7 times greater as measured at the USGS gaging station on Lake Creek.

The risk of precipitation refilling Diamond Lake and spilling lake water into Lake Creek before it is determined safe during the canal closure phase is very low. Accumulative rainfall after canal closure would have to be greater than 20 inches in order to refill the lake and return flow at the outlet to Lake Creek. The canal closure phase would occur during the last month of the low flow period, which coincides with low precipitation (September), but would possibly extend to the middle of the fall rainy season (early November). Based on historic weather data, the average rain fall for this time period (September 15th to November 15th) was 7.5-inches and the probability of receiving as much as 20 inches is extremely low. However, a mitigation measure is incorporated into both Alternatives 2 and 3 that would reconstruct the outflow structure of Diamond Lake in Lake Creek to an elevation that would contain any unexpectedly large amount of rainfall during this two month period.

Inert Ingredients, Metabolites, and other Chemicals

Chemical manufacturers often add other ingredients to their formulations, called inert ingredients, to enhance effectiveness. The powdered formulation, Pro Noxfish® that would be applied to the Lake has no added inert ingredients; it is composed simply of the ground up plant material. The liquid Noxfish® that would be applied to Short and Silent Creeks (a total of roughly 375 gallons), contains inert emulsifiers, solvents, and carriers

that are important in ensuring the solubility and dispersion of this liquid formulation. Water treated with Noxfish® was found to contain rotenolone (the metabolite of rotenone), and volatile organic compounds (trichloroethylene, xylene, toluene, and trimethylbenzene) and semi-volatile organic compounds (naphthalene, 1-methyl naphthalene, and 2-methyl naphthalene). These volatile and semi-volatile organic compounds naturally breakdown and dissipate in treated water before rotenone and rotenolone (Finlayson et al. 2000).

Five California rotenone projects were monitored for the fate of the compounds of powdered and liquid formulations including inerts in sediments (Finlayson et al, 2001). Only the naphthalene and methyl naphthalene (associated with Noxfish®) temporarily accumulated in sediments, but this was for a period of less than 8 weeks. The other inert compounds in Noxfish® did not persist in sediments.

Nine California rotenone projects were monitored for the inert ingredients in Noxfish® in surface water (Finlayson et al, 2001). All ingredients were well below the minimum concentrations allowed under maximum contaminant levels (MCLs) for these ingredients in drinking water standards set by the EPA (Finlayson, 2001). Of the seven organic compounds found in Noxfish, trichloroethylene (TCE) is the only carcinogen; the rest are considered non-carcinogens. However, there are inconsistencies in the scientific literature regarding whether naphthalene is carcinogenic. Naphthalene was reported in one source as causing carcinogenic activity in rat nose tissue in an inhalation study (US National Toxicology Program, 2001). The bulk of the toxicology literature however supports that naphthalene is not carcinogenic.

Considering this information, none of the chemicals associated with the powdered or liquid forms of rotenone proposed for use would be expected to persist in the environment for more than a few weeks. Therefore, no impacts to downstream aquatic resources would be expected as a result of the proposed chemical treatment.

HABITAT ELEMENTS

Physical Barriers: The Diamond Lake Restoration project would have no impact to physical barriers on the main stem North Umpqua River.

Large Woody Material: As channel size increases, the size required for LWD pieces to remain stable also generally increases. The role and frequency of LWD generally decreases in large, confined channels like the analysis section of the North Umpqua, although accumulations of LWD into large debris jams are locally important. Currently, densities of large wood within the North Umpqua River are very low and believed to be well below that which would exist in a river bordered by the type of late seral forest that is found along the North Umpqua.

The majority of the wood mobilization that occurs in the North Umpqua River coincides with larger storm/stream flow events. Therefore, it is highly unlikely that a 3% increase in stream flow (see FLOW/HYDROLOGY section below) would result in mobilization

and flushing of larger wood in the North Umpqua River. Therefore, activities associated with the draw down portion of the Diamond Lake Restoration Project would not impact large wood loading in this system.

Subtrate: The majority of the stream bed and banks of the North Umpqua River are considered to be well armored with bedrock, boulders, and cobble substrates. Limited gravel substrates can be found in association with depositional features such as stable large wood, boulder formations, or certain bedrock outcroppings. As a result, these substrates are relatively stable. Based upon the extremely small increases (see FLOW/HYDROLOGY section below) in stream flow that are likely to occur during the draw down portion of the project, it is highly unlikely that any changes in substrate size, amount, or distribution would occur as a result of the Diamond Lake Restoration Project.

Pool Character: The vast majority of the pools in the North Umpqua River main stem are formed as a result of variations in large boulder and bedrock formations, not scour into alluvial substrates. As a result, these pools are inherently stable. It is highly unlikely that any changes in pool character would occur as a result of minor stream flow increases caused by the draw down portion of the Diamond Lake Restoration Project.

Low Velocity Refuge: Low velocity refuge habitat typically occurs in side channels, on floodplains, or in association with complex accumulations of large woody material. In the North Umpqua River, this low velocity refuge habitat is in relatively short supply naturally when compared to other rivers of this size. Overall, side channels are rare habitat features along the North Umpqua River, floodplains are limited in size and extent, and large wood is relatively infrequent. As mentioned below, the relatively small increase in stream flow that would occur during the draw down phase of the Diamond Lake Restoration Project is considered to be insignificant. It would be highly unlikely to negatively impact the amount of low velocity refuge habitat in this system.

Refugia: Based on the consistently large amounts of relatively cold water during the Summer months, the entire main stem portion of the Middle North Umpqua 5th field watershed could be considered as an anadromous fish refuge. The Diamond Lake Restoration Project would have no negative impact on this condition.

CHANNEL CONDITION AND DYNAMICS

Width/Depth Ratio: The majority of the stream bed and banks of the North Umpqua River are considered to be well armored with bedrock, boulders, and cobble substrates. As a result, channel dimensions in this river are not easily changed. It is highly unlikely that changes in width/depth ratio would occur as a result of the extremely small increases in stream flow that would occur during the draw down portion of this project.

Streambank Condition: The majority of the stream banks of the North Umpqua River are considered to be well armored with bedrock, boulders, and cobble substrates. As a result, these banks are considered to be inherently stable. Based upon the extremely

small increases in streamflow that would be expected during the draw down phase of this project, it is highly unlikely that any change to streambank condition would occur.

Floodplain Connectivity: No floodplain impacts, or channel incision would be expected along the main stem North Umpqua River as a result of this project. Therefore, the Diamond Lake Restoration Project would have no impact on floodplain connectivity.

FLOW/HYDROLOGY

Changes in Peak/Base Flows: Once the draw down flow reaches Lemolo Reservoir, it would be absorbed into the larger reservoir until a flow equilibrium is reached. In addition, a portion of this increased flow would be absorbed through reservoir operations. PacifiCorp is a partner in this project and would work with the draw down operation to avoid large changes in reservoir storage and release. Therefore, no major changes in the seasonal streamflow regime below Lemolo Dam in the North Umpqua River would be expected.

Minor changes to fall, winter, and early spring base flows in the North Umpqua River below Soda Springs Dam are likely to occur as a result of the Diamond Lake draw down. These changes would result in an average base stream flow increase of approximately 50 cfs for a 4-7 month period. However, no changes to peak flow levels would be expected from this project due to the fact that naturally occurring storm-generated flows would be allowed to flow through the system, without additional drawdown flow volumes added to them. Once these large storm flows recede below the bankfull stage, additional water from the lake would again be added in order to bring stream flows back up to bankfull levels, and continue the drawdown process.

The bankfull flow in the North Umpqua River below Soda Springs Dam is approximately 5,500 cfs (as measured at the USGS gauge below Soda Springs dam). The average monthly flow of the North Umpqua River during the draw down period is approximately 1,560 cfs. *In Water Resources Data publications by USGS, the accuracy of the flow measurements at the North Umpqua River above Copeland Creek gage is described as being within 10 percent of the actual for 95 percent of the flows.* While the minor flow increases mentioned above would be likely to occur, the average increase of 50 cfs is within the measurement error of the stream gauge at the Copeland site, and represents roughly 3 percent of the average base flow of the North Umpqua River at this location during the proposed draw down period. Therefore, this minor flow increase meets the definition of an insignificant effect where, "based on best judgement, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects" (Consultation Handbook, 1998).

In addition, a chronological evaluation of average monthly flows during each of the fall and winter months indicates that yearly variations in same-month flows have ranged from +/- 4 to over 1,000 cfs for the same month in different years. This high level of monthly flow variation over the years is clearly evident in the 54 years of flow data for this gaging station. A subset of recent data (November stream flow averages) from the North

Umpqua River below Soda Springs Dam is listed below to better illustrate the high variability in annual monthly stream flow levels.

Year	Month	Average Stream Flow (cfs)
1994	November	792
1995	November	1,295
1996	November	2,324
1997	November	1,241
1998	November	1,697
1999	November	1,177
2000	November	934
2001	November	902

Drainage Network: No roads would be constructed or decommissioned as a result of this project. Therefore, no changes in drainage network would be anticipated as a result of the Diamond Lake Restoration Project.

WATERSHED CONDITIONS

Road Density: The Diamond Lake Restoration project would have no impact on road densities in the Middle North Umpqua River 5th field watershed.

Disturbance History: The Diamond Lake Restoration project would have no impact on the disturbance history of the Middle North Umpqua River 5th field watershed.

Riparian Reserves: The Diamond Lake Restoration project would have no impact on riparian reserves in the Middle North Umpqua River 5th field watershed.

Landslide Rates: The Diamond Lake Restoration project would have no impact on landslide rates within the Middle North Umpqua River 5th field watershed.

Determination of Effects

The biological evaluation is a 5-step process. Each Proposed, Endangered or Threatened and Sensitive species (PETS) potentially occurring within the project area was evaluated based on these steps. Evaluation of impacts on a given species may be complete at the end of step #1 or may extend through step #5 (Table X). If the species' habitat is not present then no further review is necessary. Step 5, biological investigation, is not displayed. If data is insufficient to assess the significance, a biological investigation would have been done, but such an investigation was not deemed necessary. The effects determinations displayed in the table below represent the alternatives presented in the EIS.

Review Process	Step #1 Prefield Review	Step #2 Field Recon	Step #3 Effects Determination	Step #4 Conclusion of Effects			
	Habitat Present	Species Present	Effects	Determination by Alternative			
Invertebrates *				1	2	3	4
Mt. Hood primitive caddisfly	no	no	no	NI	NI	NI	NI
Cascades apatanian caddisfly	no	no	no	NI	NI	NI	NI
Tombstone Prairie caddisfly	no	no	no	NI	NI	NI	NI
Alsea micro caddisfly	no	no	no	NI	NI	NI	NI
Fish **							
Oregon Coast coho salmon	no	no	yes	NLAA	NLAA	NLAA	NLAA
Oregon Coast steelhead trout	no	no	yes	MIIH	MIIH	MIIH	MIIH
Umpqua chub	no	no	no	NI	NI	NI	NI
Oregon Coast cutthroat trout	no	no	yes	MIIH	MIIH	MIIH	MIIH
Oregon Coast chinook salmon	no	no	yes	MIIH	MIIH	MIIH	MIIH
EFH	no	no	yes	WNAA	WNAA	WNAA	WNAA

*Field review of species presence and habitat was conducted by Bob Wisseman, Aquatic Biology Associates, Inc.
**The nearest habitat for anadromous fish is located approximately 33 miles downstream of Diamond Lake, in the North Umpqua River below Soda Springs Dam.

Key to determinations:

·The threatened coho determination calls follow the nomenclature established by NOAA Fisheries:

NE= No Effect, NLAA= Not Likely to Adversely Affect, LAA= Likely to Adversely Affect

·EFH determinations: WNAA = Would not Adversely Affect, MAA = May Adversely Affect

·For sensitive species including all species except coho, determinations follow the nomenclature established in the Forest Service Handbook:

NI= no Impact;
MIIH= May Impact Individuals or Habitat but will not Likely Contribute to a Trend Towards Federal Listing or Cause a Loss of Viability to the Population or Species;
WIFV= Will Impact Individuals or Habitat with a Consequence that the Action May Contribute to a Trend Towards Federal Listing or Cause a Loss of Viability to the Population or Species

Essential Fish Habitat (EFH) Under the Magnuson-Steven Fishery Conservation and Management Act (MSA)

The MSA requires Federal agencies to consult with the Secretary of Commerce regarding any action or proposed action authorized, funded, or undertaken by the agency that may adversely affect essential fish habitat (EFH) identified under this law. The MSA defines adverse effects as any impact, which reduces the quality and/or quantity of essential fish habitat. Adverse effects include direct, indirect, site specific or habitat wide impacts, including individual, cumulative or synergistic consequences of actions. This law deals with commercial fisheries. Coho and Chinook salmon are considered for this project.

The Diamond Lake Restoration project is expected to have an extremely low likelihood of causing an effect upon EFH, the species considered, and their major freshwater prey species. Major prey species are considered to be a variety of aquatic macroinvertebrates, including but not limited to the aquatic and winged adult phase of the following insect groups: stoneflies, mayflies, caddisflies, and midges. No substantial direct, indirect, cumulative, or synergistic effects to EFH are anticipated under the project. Coho and Chinook salmon are not found in the vicinity of the project planning area; and the chances of any effect being realized are so small as to be considered discountable and insignificant. Therefore, the proposed action and its alternatives have been given the following EFH effects determination: **"Would not Adversely Affect".**

Table x. Ranking the Risk Associated With Each Alternative within the Range of the NLAA Determination.

Alternative	Risk Ranking (greatest=1 lowest=4)	Rationale *pros/cons
1 (No Action)	1	Would not eradicate tui chub from Diamond Lake. Lake would continue to have poor water quality and toxic algae blooms. Nitrogen rich water would continue to flow into the North Umpqua System via Lake Creek, contributing to increased algal productivity downstream.
4 (Mechanical & Biological)	2	Would not eradicate tui chub from Diamond Lake. Lake would continue to have poor water quality and toxic algae blooms. Nitrogen rich water would continue to flow into the North Umpqua System via Lake Creek, contributing to increased algal productivity downstream.
2 (Proposed Action)	3	Treats Diamond Lake to eradicate tui chub. Restocks lake with fingerlings and triploid Eagle Lake rainbow trout. Water quality is greatly improved, and amounts of nitrogen in water entering North Umpqua system (via Lake Creek) are reduced, thereby reducing Diamond Lake's contribution to increased algae growth downstream.
3 (Put and Take Fishery)	4	Treats Diamond Lake to eradicate tui chub. Restocks lake with highly domesticated put-and-take rainbow trout. Water quality is greatly improved, and amounts of nitrogen in water entering North Umpqua system (via Lake Creek) are reduced, thereby reducing Diamond Lake's contribution to increased algae growth downstream.

*The pros and cons for each alternative are within the range of the NLAA call and have been used to rank the risk of the alternatives within the NLAA range. In all alternatives, the potential for impacts to coho salmon resulting from the Diamond Lake project are so small as to be considered insignificant and discountable.

Dichotomous Key for Making ESA Determination of Effects
Project: Diamond Lake Restoration Project

1. Are there any proposed/listed anadromous salmonids and/or proposed/designated critical habitat in the watershed or downstream from the watershed?
   NO.....No Effect
   YES.....Go to 2

2. Will the proposed action have any effect whatsoever[1] on the species and/or critical habitat?
   NO.....No Effect
   YES.....Go to 3

3. Does the proposed action(s) have the potential to hinder attainment of relevant properly functioning indicators?
   NO.....Go to 4
   YES..... Likely to Adversely Affect

4. Does the proposed action(s) have the potential to result in "take"[2] of proposed/listed anadromous salmonids or destruction/adverse modification of proposed/designated critical habitat?

   A. There is a negligible (extremely low) probability of take of proposed/listed anadromous salmonids or destruction/adverse modification of critical habitat .....Not Likely to Adversely Affect

   B. There is more than a negligible probability of take of proposed/listed anadromous salmonids or destruction/adverse modification of critical habitat .....Likely to Adversely Affect[3]

Biologist: _Scott W. Lightcap_ Date: __02/27/04_____

[1] "Any effect whatsoever" includes small effects, effects that are unlikely to occur, and beneficial effects. I.E., a "no effect" determination is only appropriate if the proposed action will literally have no effect whatsoever on the species and/or critical habitat, not a small effect, an effect that is unlikely to occur, or a beneficial effect.

[2] "Take" – The ESA (Section 3) defines take as "to harass, harm, pursue, hunt, shoot, wound, trap, capture, collect, or to engage in any such conduct. The USFWS further defines "harm" as "significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering", and "harass" as "actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering".

[3] Document expected incidental take on reverse side of this key.