March 28, 2006

Magalie R. Salas, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Re: RECOMMENDATIONS ON TERMS AND CONDITIONS
Project No. P-2082, Klamath River Hydroelectric Project

Dear Ms. Salas:

Please find enclosed the Yurok Tribe's RECOMMENDATIONS ON TERMS AND CONDITIONS for the above referenced project.

The Yurok Tribe hereby submits its recommendations for terms and conditions related to the relicensing of the Klamath Hydroelectric Project (KHP) on the Klamath River in California and Oregon. The terms and conditions recommended here are being submitted to the Federal Energy Regulatory Commission (FERC) pursuant to Title 18 Code of Federal Regulations Section 4.34(b)(2) and Section 10 (16 USC §§ 803) of the Federal Power Act, particularly subsection (a) concerning the protection and mitigation of fish and wildlife resources, including the water quality upon which they depend. Full rationale and justification, along with supporting data and references are included.

It is the Yurok Tribe's sincerest hope that the Commission will seriously consider the Tribe's recommendations on this important issue and will respect the Tribe as a leading expert on the Klamath River.

Sincerely,

<u>(signature)</u>

Howard McConnell, Chairman
190 Klamath Boulevard
PO Box 1027
Klamath, CA 95548
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YUROK TRIBE RECOMMENDATIONS FOR TERMS AND CONDITIONS RELATED TO THE KLAMATH RIVER HYDROELECTRIC PROJECT (P-2082)

Preliminary Federal Power Act Section 10(a) Fish and Wildlife Recommendations of the Yurok Tribe

Summary of Yurok Tribe's Recommendations

The Yurok Tribe hereby submits its recommendations for terms and conditions related to the relicensing of the Klamath Hydroelectric Project (KHP) on the Klamath River in California and Oregon. The terms and conditions recommended here are being submitted to the Federal Energy Regulatory Commission (FERC) pursuant to Title 18 Code of Federal Regulations Section 4.34(b)(2) and Section 10 (16 USC §§ 803) of the Federal Power Act, particularly subsection (a) concerning the protection and mitigation of fish and wildlife resources, including the water quality upon which they depend. Full rationale and justification, along with supporting data and references are included.

The Yurok Tribe recommends that FERC deny the license, and instead, order the licensee (Pacific Corp) to remove JC Boyle, Copco 1 and 2, and Iron Gate Dam as soon as possible. FERC should order PacifiCorp to work with affected Tribes, the States of California and Oregon, and appropriate Federal agencies including FERC, to draft a removal plan that will result in the decommissioning and removal of those facilities as soon as possible.

In the alternative, the Yurok Tribe recommends that FERC relicense the project with the condition that the lower four PacifiCorp facilities (JC Boyle, Copco 1 and 2, and Iron Gate Dam) be removed within ten years or less upon a schedule to be determined by FERC.

FERC should also enlist the help of stakeholders, agencies, and outside experts to decide the future fate of Iron Gate Hatchery and other potential artificial propagation in the event of decommissioning, and to determine how the hatchery could best contribute toward restoration efforts in the Klamath Basin.

The Yurok Tribe believes that the following rationale provide the basis for FERC to order the removal of the above-mentioned four dams:

- As noted by the California Energy Commission, the KHP provides minimal power benefits to the region, especially when compared to new sources that have recently come on line, or are planned for the near future.
    - KHP provides approximately 1.3% of PacifiCorp total power production.
- The benefits of the project simply do not compare with the tremendous costs to the public, and for most of the impacts, there are no available protection, mitigation, or enhancements.

- The KHP is antiquated and would have exceeded it's engineered life expectancy by the end of a new license, therefore it is considered by the Yurok Tribe to be a safety hazard. For example, at the end of a 50-year license, Copco 1 will have been in existence for 138 years.
- PacifiCorp proposed no fish passage in their final license; based on the premise that they provide adequate mitigation by way of production at Iron Gate Hatchery (IGH). This rationale is flawed because:
  - IGH does not mitigate for lost production from more than 700 km of anadromous habitat above Copco 2 Dam.
  - IGH does not mitigate for the loss of Spring Chinook salmon, or lamprey, and does an abysmal job of mitigating for steelhead.
  - IGH provides no fish to the upstream Klamath Tribes.
- PacifiCorp's own fish passage and production modeling show that removal of these four dams offers the most restoration potential of the options explored.
- Fish passage through the project is unlikely to be successful with lamprey and Chinook salmon recolonizing the far reaches of the Upper Klamath Basin that have an ocean-type life history[1].
- PacifiCorp proposes no mitigation for the KHP negative effects to temperature, nutrients, dissolved oxygen (beyond immediate project effects), pH, ammonia and toxic blue-green algae, which has become a major public health risk.

Introduction

The Yurok Tribe is the largest Indian Tribe in California, and holds federally reserved fishing and water rights on the Klamath River. The Tribe has disproportionately borne the negative impacts of the Klamath River Hydroelectric Project (KHP) for decades while seeing little or no benefit. The Tribe is not alone in bearing these costs, as the KHP dramatically affects the fisheries and associated communities along the entire west coast of the United States, while providing very little in the way of benefits to the public.

The Yurok Tribe hereby recommends under Section 10(a) of the Federal Power Act, that FERC deny PacifiCorp's request for a new license, and instead order the immediate removal of the lower four PacifiCorp facilities (JC Boyle, Copco 1 and 2, and Iron Gate Dam) from the Klamath River. PacifiCorp should be required to come up with a decommissioning strategy for these facilities for FERC's approval within one year of the denial of the new license, and physical

[1] Huntington et al; 2006 Reintroduction of Anadromous Fish to the Upper Klamath Basin: an Evaluation and Conceptual Plan.

removal should begin within 5 years, provided that the necessary permits and environmental analysis is completed. FERC should also enlist the help of stakeholders, agencies, and outside experts to decide the future fate of Iron Gate Hatchery in the event of decommissioning, and to determine how the hatchery and other artificial propagation efforts could best contribute toward restoration efforts in the Klamath Basin.

We recommend these actions because of the tremendous impact that the KHP dams have on the water quality and anadromous fishery of the Klamath River. These impacts affect not only the Yurok Tribe, but the entire west coast fishing industry of the United States[2]. We recommend denial of the license because of PacifiCorp's repeated statements that they cannot, or will not, mitigate for a vast majority of their impacts. Furthermore, PacifiCorp's own fish passage and production modeling show that removal of these four dams offers the most restoration potential of the options explored.

FERC should follow our recommendation to order the removal of the four dams because of the federal Tribal Trust obligation to protect resources important to the Yurok and other Indian Tribes in the Klamath Basin. FERC should heed the recommendations of the Yurok Tribe given that the Tribe is a leader in fisheries management, fisheries restoration, watershed restoration, clean water monitoring, cultural resources management, and historic preservation in the Klamath River Basin.

PacifiCorp's license should also be denied because they have proposed no fish passage in their final license application; based on the premise that they provide adequate mitigation by way of production at Iron Gate Hatchery. This logic is flawed for several reasons: 1) Iron Gate Hatchery does not mitigate for any of the lost production from above Copco 2 Dam (more than 700 km of anadromous fish habitat), 2) Iron Gate Hatchery returns no fish to our upstream neighbors, the Klamath Tribes, 3) Iron Gate Hatchery does not mitigate for the loss of spring Chinook salmon, 4) Iron Gate Hatchery does not mitigate for the loss of lamprey, and 5) Iron Gate Hatchery has done an abysmal job of mitigating for steelhead and 6) Iron Gate Hatchery is not able to mitigate for damage to the fishery caused by the PacifiCorp dams in question.

Furthermore, FERC can only find relatively minor benefits of the Project; in light of the California Energy Commission's finding that the amount of electricity produced by this project is relatively insignificant. New sources have recently come on line, or are planned for the near future that can and will mitigate any power losses due to dam removal and will in fact greatly increase local power generation.

The national significance of the Klamath River and its fishery, the inability (or unwillingness) of PacifiCorp to mitigate for the most serious impacts of the KHP, the lack of ancillary benefits (such as flood protection or water supply), and the

[2] Scarcity of Klamath River fall-run Chinook salmon constrains ocean fishing over a large area of the west coast, resulting in millions of dollars of lost revenue per year. This year's closure of nearly the entire west coast serves to underscore this importance.

relatively small amount of electricity produced by this project all point to the inescapable conclusion that this project is no longer in the public interest, and thus FERC should deny the new license and order the removal of the lowermost four dams in the KHP.

The issues surrounding the KHP are complex, and there are many stakeholders with different points of view. However, the core of the issue here is very simple. The KHP is an antiquated, small hydroelectric project on a nationally significant river. The benefits of the project simply do not compare with the tremendous costs to the public, and for most of the impacts, there are no available protection, mitigation, or enhancements. We believe that FERC's duty is to weigh these issues against each other, and we believe that if FERC does this in an objective manner, FERC will reach the conclusion that the presence of the KHP on the Klamath River is not consistent with the intent of the Federal Power Act. The dams provide little public electrical benefit and causes huge fisheries and economic losses.

The Yurok Tribe's Interests With Regard to the Klamath River Hydroelectric Project

The Yurok Tribe is the largest Indian Tribe in California with over 4800 tribal members. The Yurok Indian Reservation is located along the lower 44 miles of the Klamath River, and the Klamath River forms a central axis of culture and economy. Fish, including spring and fall-run Chinook salmon, coho salmon, steelhead, lamprey, and sturgeon continue to sustain a living culture to this day. The river and its health are of central importance to the Yurok Tribe.

The fishing rights of the Yurok Tribe are well established as a matter of federal law. The Yurok Reservation, created pursuant to an 1855 act of Congress, was established within the Yurok Tribe's aboriginal homeland primarily to provide a territory in which the Tribe's fishing-based culture and way of life could thrive. This fact has been recognized repeatedly since the Reservation was established -- by the Department of the Interior, the United States Supreme Court, the lower federal courts, and the California courts. See, e.g., Mattz v. Arnett, 412 U.S. 481, 487 (1973); Parravano v. Masten, 70 F.3d 539, 545-46 (9th Cir. 1995), cert. denied, 116 S. Ct. 2546 (1996); Blake v. Arnett, 663 F.2d 906, 909 (9th Cir. 1981). As Justice Blackmun observed in Mattz v. Arnett, the original Klamath River Reservation, the precursor to the current Yurok Reservation, "abounded in salmon and other fish" and was in all ways "ideally suited for the Yuroks." 412 U.S. at 487.

Because the Reservation was created in order to secure the Yuroks' fishing opportunities, the right of the Yurok Tribe to take fish on the Klamath River is protected and guaranteed by federal law. The Ninth Circuit Court of Appeals has confirmed that the executive orders that created the Yurok Reservation vested the Yurok Tribe with "federally reserved fishing rights." Parravano v. Masten, 70

F.3d 539, 541 (9th Cir. 1995), cert, denied, 518 U.S. 1016 (1996). The same court has aptly observed that the salmon fishery of the Yurok Tribe is "not much less necessary to the existence of the Indians than the atmosphere they breathed." Blake v. Arnett, supra, at 909. The Solicitor of the Department of the Interior has determined that the Yurok and Hoopa Valley Tribe are entitled to a sufficient quantity of fish to support a moderate standard of living, or 50% of the Klamath fishery harvest in any given year[3]. This right for Klamath Basin Tribes to harvest 50% of the harvestable surplus of each run of fish, of which the Yurok Tribe is allocated 80%, includes fishing for subsistence, commercial and cultural purposes. This has been followed up by the Pacific Coast Fisheries Management Council, (established by the Magnusson-Stevens Fishery and Conservation and Management Act), with a 50% allocation of fish from the Pacific Coast Fisheries Management Council since the early 1980's.

The Yurok Tribe's fishing right gives it a federal reserved water right under the premise that a fishing right is meaningless without adequate water quality and quantity to support the fishery. The Interior Regional Solicitor has determined that the Yurok Tribe has a federal reserved right to an instream flow of water of the quantity and quality in the Klamath River sufficient to support the Tribe's rights to take its allowable share of fish within the Yurok Reservation. The Regional Solicitor has directed the Bureau of Reclamation to operate the Project to ensure that project operations not interfere with the senior water rights of the Klamath Basin Tribes. Memorandum of Regional Solicitor to Regional Director, Bureau of Reclamation, July 25, 1995. The federal courts have confirmed that the Federal Government has a binding trust obligation to protect the Yurok Tribe's senior water rights in the Klamath Basin. Klamath Water Users Protective Association v. Patterson, 204 F.3d 1206 (9th Cir.), cert. denied, 121 S.Ct. 44 (2000).

As recently as 1988, Congress, in the Hoopa Yurok Settlement Act, chose not to limit Yurok fishing rights   Governmental testimony regarding the act estimated that the Yurok Tribe would receive the benefit of a million dollar a year fisheries.

Much of the reservation has no electric power, and people here use generators, alternative energy, or simply live without electricity. Despite this, the Yurok Tribe has disproportionately borne the impacts of the KHP with little or no relief for many decades. The KHP has had a profound impact on the fisheries resources and water quality of the Klamath River upon which the Yurok Tribe depends for cultural, subsistence, and economic reasons. These impacts have dramatically altered the lives of Yurok People, yet little or no benefit has accrued to Tribal members. This disproportionate impact upon the Tribe, with no resultant benefit to the Tribe, is clearly an issue of environmental justice, and must be appropriately addressed in FERC's EIS for this relicensing.

The Yurok Tribe has patiently participated in this relicensing forum, because the Tribe had sincerely believed that PacifiCorp's hybrid "collaborative/traditional" relicensing process would finally bring these impacts to the light of day, and long

[3] Memorandum from Solicitor to Secretary of the Interior, No. M-36979, October 4, 1993.

overdue relief would be obtained. We have tried to work with PacifiCorp in good faith, but have been disappointed time and again by the company's refusal to acquire needed information, their outright refusal to consider any mitigation at all for major impacts to the fishery, and their continued stance that status quo operations of the Klamath Hydroelectric Project should continue into the future. In their Final License Application, PacifiCorp states that, "*No operational changes are proposed at this time as part of this Project relicensing and PacifiCorp does not plan to make any Project generation additions in the foreseeable future.*"[4] The Yurok Tribe believes that this is an unacceptable position, and is not in the public interest.

Why FERC Should Heed the Recommendations of the Yurok Tribe

FERC should heed the recommendations of the Yurok Tribe for three primary reasons:

1. FERC has a recognized Tribal Trust obligation which means that FERC is responsible for managing Trust Assets of the Tribe in a responsible manner. This obligation goes beyond mere consultation, and requires FERC to take active measures to protect such Trust Assets;
2. The Yurok Tribe is a leader in the field of fisheries management in the Klamath Basin, and has the scientific expertise necessary to make recommendations regarding the resources of the Klamath Basin;
3. PacifiCorp has stated that it cannot, or will not, mitigate for most of the severe impacts that the KHP has had on the Yurok Tribe.

The Yurok Tribe believes that the record in this relicensing proceeding is sufficiently clear to determine that the KHP should be decommissioned. Even PacifiCorp has asserted that they cannot mitigate for many of the most substantial impacts of the KHP. For example, the KHP caused the extirpation of spring Chinook from within and above project, yet PacifiCorp says that a mitigation hatchery for spring Chinook is not feasible. Nor is PacifiCorp's proposing fish passage for this or any other species[5]. The hatchery mitigation program for steelhead at Iron Gate Dam cannot be considered anything but an abject failure. Likewise, PacifiCorp has asserted that it cannot mitigate for warm fall water temperatures caused by its Project that have caused a shift in run timing for fall Chinook salmon. Nor has PacifiCorp proposed mitigation for toxic

[4] PacifiCorp FLA; Exhibit B, 13-1

[5] Even if volitional passage is required, it is uncertain whether species such as Pacific lamprey would be able to utilize such facilities. This species is important to the Yurok Tribe and is in apparent severe decline. The Yurok Tribal Fisheries Program, as well as the Karuk Department of Natural Resources have begun studies to investigate this decline.

blue-green algae, (Microcystis), that now is present in the Klamath River and Yurok Reservation. While small amounts of toxic algae originate upstream the huge toxic blooms are concentrated and grown specifically by the Pacific Corp. dams. This has resulted in river and reservoir access closures by California Counties and state agencies. Such closures were to protect HUMAN HEALTH After death the algae migrate downstream preventing the harvesting of fish and interfering with traditional ceremonies on traditional historic sites.

PacifiCorp has failed to follow federally mandated procedure under the National Historic Preservation Act. Under the federal National Historic Preservation the APE is to be based upon the impacts of the project. Surveys are then mandated to precisely determine impacts. Pacific Corps has stated they drew the boundary narrowly so as to avoid the expense of downriver cultural And historical surveys. This is contrary to the findings of the Oregon Historic Preservation Officer. Similar conclusions and findings have been made by other experts in the field. Pacific Corp. by refusing to extend the KHP Area of Potential Impacts prior to conducting cultural resources studies completely neglects their statutory duties.

FERC's 10(a) Responsibilities

FERC has an obligation to balance the need for power against the KHP's effects to fish, wildlife, and other resources. In the Edwards Dam case, FERC decided, based on a 10(a) recommendation, that relicensing the Edwards Project was not in the public interest, and based on that finding, FERC denied the new license and ordered removal. FERC based this decision on an analysis of power costs under the applicant's proposed license, including the agencies' prescriptions, as compared to the cost of replacement power, in addition to the fact that inadequate fish passage was being proposed. Although an economic analysis is likely useful in this case, it should not form the sole basis of a 10(a) determination, because there are other major considerations involved with the KHP.

Furthermore, FERC should evaluate any proposed mitigation for major project impacts (of which there is scarcely any proposed), and the effectiveness of any proposed mitigations. For fish passage, PacifiCorp proposes to continue operations at Iron Gate Hatchery, which does not mitigate for spring Chinook or Pacific Lamprey, and for other project effects to the downstream fishery, PacifiCorp proposes no mitigation.

The Yurok Tribe has federally reserved fishing rights. FERC must consider its obligation to protect these tribal trust rights, rather than simply conduct an economic analysis regarding the cost/benefits associated with the KHP.

The Yurok Tribe has long acknowledged that its fishery is an economically valuable asset to the Tribe, but has resisted attempts to quantify the worth of its right to fish or the fishery itself. This is because the river, the fish, and the fishery all form a central foundation to a culture which cannot be valued with simple monetary valuation techniques. We urge FERC to be sensitive to this matter of environmental justice when evaluating the public's interest with regard to the KHP.

The Yurok Tribe believes that FERC must evaluate whether or not it can meet its obligations to the Tribes when deciding on what terms to issue this license, or whether it should deny this license and order decommissioning of the KHP. In this instance, we believe that FERC should deny the license due to 1) the fact that the amount of power generated by the project is insubstantial[6], 2) the fact that new terms and conditions under Section 18 and 4(e) are likely to render power generation at the KHP facilities uneconomical, and 3) PacifiCorp's inability to mitigate for the most serious project impacts.

Basis for Yurok Tribe's Recommendations

In 2000, the Interagency Task Force for Coordination of Federal Mandates published a position paper regarding the application of NEPA to FERC relicensing proceedings[7]. In this policy paper, the Task Force outlines a list of 17 factors that must be taken into consideration if decommissioning is to be considered as a viable alternative in the FERC process. The following comments use that list as a template to guide this general discussion since these are the factors that FERC itself will be weighing.

(1) Listed threatened or endangered species;

FERC, under Section 7 of the Endangered Species Act (ESA) will be required to submit a Biological Assessment of the impacts of Project relicensing on the species in the Basin listed as threatened or endangered.

There are three fish species listed under the Endangered Species Act in the Klamath Basin. The Southern Oregon/Northern California Coast coho salmon (SONCC) Evolutionary Significant Unit (*Oncorhynchus kisutch*) was listed as threatened under the ESA on May 6, 1997. The designation of critical habitat for the stocks within the above mentioned ESU followed in May 1999. The C'wam aka Lost River sucker (*Deltistes luxatus*) and Qapdo **(**aka shortnose sucker) (*Chasmistes brevirostris*) of the Upper Klamath Basin were listed as endangered on July 18, 1988.

PacifiCorp owns and operates five dams on the mainstem Klamath River including Keno, J.C. Boyle, Copco 1, Copco 2, and Iron Gate. No fish passage facilities are present at Iron Gate or at Copco 1 and Copco 2 dams. Substandard fish ladders are present at J.C. Boyle and Keno dams.

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[6] "Preliminary Assessment of Energy Issues Associated With the Klamath Hydroelectric Project" California Energy Commission Staff Report No. 700-03-007. May 2003.

[7] Interagency Task Force Report on NEPA Procedures in FERC Hydroelectric Licensing. 2000. Work Group on the Coordination of Federal Mandates.

“Although suckers have been observed to use the ladders, they were not designed for sucker passage and generally are inadequate for sucker passage. Access to about 54 miles of river habitat (for suckers) is blocked or restricted by these dams.”[8] Project impacts to the ESA listed species are considerable; including impacts attributable to the project since its construction.

There are approximately 77 linear miles of coho habitat that have been inundated or blocked by Project facilities. Water quality impacts to coho below Iron Gate Dam need to be assessed in addition to assessing impacts on coho population levels attributable to the project since its construction.

The *Final ESA Section 7 Consultation Handbook* (USFWS and NMFS 1998) includes the following instructions for proceeding with consultation when there is an absence of conclusive scientific information:

> If the action agency... insists consultation be completed without the data or analyses requested, the biological opinion... should document that certain analyses or data were not provided and why that information would have been helpful in improving the data base for the consultation...The Services are then expected to provide the benefit of the doubt to the species concerned with respect to such gaps in the information base (H.R. Conf. Rep. No. 697, 96th Cong., 2nd Sess. 12 (1979)).

In addition, the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) mandates Federal action agencies which fund, permit, or carry out activities that may adversely impact the essential fish habitat (EFH) of Federally managed fish species to consult with the National Marine Fisheries Service (NMFS) regarding the potential adverse effects of their actions on EFH(Section 305 (b)(2)). §Section 600.920(a)(1) of the EFH final regulations state that consultations are required of Federal action agencies for renewals, reviews, or substantial revisions of actions if the renewal, review, or revision may adversely affect EFH.). The Pacific Fisheries Management Council has identified and described EFH for Chinook and coho salmon in the Klamath Basin under Amendment 14 to the Pacific Coast Salmon Fishery Management Plan (PFMC, 1999). The statute also requires Federal action agencies receiving NMFS’ Essential Fish Habitat Conservation Recommendations to provide a detailed written response to NMFS within 30 days upon receipt detailing how they intend to avoid, mitigate or offset the impact of the activity on EFH (Section 305(b)(4)(B).

Essential fish habitat is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of EFH, “waters” include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; “substrate”

[8] Bureau of Reclamation 2002 Biological Assessment at p. 27

includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.[9]

(2) Economic viability of a project, including costs of resource protection measures;

Complete and accurate information related to economic viability of the Project should have been provided by PacifiCorp in Final License Application (18CFR 4.51 (2) (e). Appendix D is incomplete[10] and provides Tribes and Agencies with no opportunity to discuss PacifiCorp's assessment of information pertinent to the fair value of the project or replacement costs. Nor does the FLA provide information on resource protection in the form of project mitigation and enhancement measures. As such FERC should find the application incomplete. In the alternative if FERC deems the application complete it should note the absence of evidence sufficient to support the assertions of Pacific Corp. regarding economic viability and must weigh the clearly demonstrated economic costs of continuing to operate the dams.

PacifiCorp owns and operates 53 hydroelectric plants and serves as operator for two additional projects. These facilities are located throughout several states including Oregon, Washington, California, Idaho, Utah, and Montana. The projects contain a total of 91 turbine generator units, which represent an installed capacity of approximately 1,100 megawatts (MW), or about 12.8 percent of PacifiCorp's current total generating capacity.(Exhibit H at 1-1) The capacity for production of the total Klamath Project is 150 MW, but average annual production is much less due to flow constraints. As a rough estimate one could assume the Project produces approximately 10 percent of PacifiCorp's installed hydropower capacity, or approximately 1.3 percent of their total generating capacity.

PacifiCorp's future West Coast plans call for the addition of up to 1,200 MW of peaking capacity to be added over the plan period 2006 to 2013. (H at 2-4) Replacement costs for the Klamath Project should be calculated as adjunct to planned new projects rather than as stand alone new replacement facilities.

The California Energy Commission (CEC) completed a report regarding the contribution of the KHP to western power supplies[11]. The CEC concluded that "in terms of the potential impact to electricity resource adequacy, decommissioning one or more of the dams is a viable alternative that should be examined during the proceedings on the possible renewal of the FERC hydroelectric license [for the KHP]." It is clear that the electric energy benefits to the west coast as a whole are minimal when compared to the overall

[9] National Marine Fisheries Service Biological Opinion on Klamath Project Operations, May 31, 2002.
[10] The California Energy Commission also said this in their comments regarding the KHP.
[11] "Preliminary Assessment of Energy Issues Associated With the Klamath Hydroelectric Project" California Energy Commission Staff Report No. 700-03-007. May 2003.

demand increases that are forecast and the new generation that is planned for the Klamath Falls area[12].

It is falsely believed by many that the construction of Iron Gate Dam was necessary to alleviate flow fluctuations in the mainstem Klamath resulting from Project peaking operations. Rather, as noted by the FERC in 1963:

> Licensee [Copco at the time] could have applied for authorization to change its method of operation of the Copco plants, thereby obviating the necessity for the re-regulating facility [Iron Gate Dam] and leaving the spawning areas undiminished. For purely economic reasons it chose not to do so, and has created an impassable barrier which the evidence indicates will have a deleterious effect on the pre-existing fish populations. (Emphasis added).[13]
>
> Although suitable regulation of the river flow could have been achieved through operating Copco No. 1 and Copco No. 2 as steady flow plants rather than peak load facilities, and the Commission could have directed Licensee so to modify its operations, this would have resulted in a loss of one-half of the 56,000 kw generating capacity of the plants.[14]

(3) River targeted for fish recovery;

In 1986 Congress passed Public Law 99-552; the *Klamath River Basin Conservation Area Restoration Program.*[15] Among the Congressional declaration of findings that precipitated the Act was the consideration that the Klamath Basin provides “fishery resources necessary for Indian subsistence and ceremonial purposes, ocean commercial harvest, recreational fishing, and the economic health of many local communities.” Further, Congress found that the construction of and operation of dams, diversions, and hydroelectric projects were among the factors which have significantly reduced the anadromous fish habitat in the Klamath Basin. The Restoration Program has as its goal “to restore the anadromous fish populations of the Area to optimum levels and to maintain such levels.” (16 CFR §460 the “Klamath Act”).

As a result of the Klamath Act, the Klamath Task Force prepared a Long-Range Recovery Plan[16], which was filed in this proceeding as a comprehensive plan.

In addition, the National Marine Fisheries Service is developing a recovery plan for Southern Oregon Northern California Ecologically Significant Unit of

[12] ibid
[13] FERC Opinion (#381) and Order on Petition to Construct Fish Hatchery. March 14, 1963
[14] ibid. at footnote 15
[15] Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program. Klamath River Basin Fisheries Task Force, January 1991.
[16] Ibid.

coho salmon as required by the Endangered Species Act, which will be applied to coho recovery in the Klamath Basin.

It is the goal of the Klamath River Inter-Tribal Fish and Water Commission Tribes to provide volitional access, restore, and maintain populations of anadromous fish at harvestable levels throughout their historic range including areas within the Upper Klamath Basin above Iron Gate Dam. To this end, the Yurok Tribe, along with three other Basin Tribes (Klamath Tribes, Hoopa Valley Tribe, and the Karuk Tribe of California), has submitted an anadromous fish reintroduction plan[17] along with this plan.

Finally, we believe that the situation that is unfolding right now underscores the importance of the Klamath River. Currently, the runs of fall-run Chinook salmon are projected to be so low that it may preclude fishing on nearly the entire west coast of the United States from Cape Falcon Oregon to south of San Francisco. This is despite relatively robust runs of fish projected for both the Sacramento and Rogue Rivers this year. Thus, due to poor Klamath River returns, hundreds of thousands of fish from other rivers will not be harvested in the ocean. This will lead to economic losses well over $100 million during 2006 alone, not to mention the impacts to Tribal cultures..

(4) Feasibility of fish passage;

PacifiCorp has completed a series of model runs intended to address this very question, and their own modeling shows that the most effective reintroduction and passage would be accomplished through project decommissioning, i.e. dam removal. PacifiCorp's scientific evidence shows that volitional passage would result in viable runs of salmon and steelhead above the KHP. However, the same science shows that decommissioning would provide the most effective means to accomplish the goal of reintroducing all species of anadromous fish to their historic range.

PacifiCorp has stated that in their view, reintroduction should not be attempted because Iron Gate Hatchery could successfully mitigate the current lack of fish passage. This is completely untrue, because the hatchery would not mitigate for spring Chinook and lamprey, nor adequately mitigate for steelhead. For these species, PacifiCorp has proposed no mitigation, and this is unacceptable to the Yurok Tribe. These species are all part of the fisheries trust of the Yurok Tribe in addition to fall-run Chinook salmon. This is a complete failure to meet public trust responsibilities.

For spring Chinook salmon, coho salmon, steelhead, and Pacific Lamprey, trap-and-haul strategies will not work, due to simple logistics considerations, and PacifiCorp has proposed no other mitigation. For steelhead and lamprey, downstream migrants cannot be separated from resident juveniles. For coho salmon, it would be impossible to ascertain the ultimate destination of adults,

[17] Huntington et al; 2006 Reintroduction of Anadromous Fish to the Upper Klamath Basin: an Evaluation and Conceptual Plan.

considering that there are multiple facilities in the river[18]. Dam removal is the surest way to achieve reintroduction goals for these species.

(5) Consistency with comprehensive plan(s);

Relevant plans that have been submitted to FERC include the long range plan of the Klamath River Basin Task Force, which calls for the restoration of the fisheries resources of the Klamath River, and the BLM Land Use Plan, which also lists the maintenance and enhancement of the fisheries resources of the Klamath as a primary objective.

FERC will be considering all comprehensive plans that have been, or will be, submitted. PacifiCorp should be cognizant of the fact that, by nature of the area, most if not all comprehensive plans for the beneficial use of the River take into consideration fish population health and productivity.

From the Klamath and Yurok Tribe's anadromous fish reintroduction plan[19]

> The Tribal goal of restoring native anadromous fish to historically used habitat in the Upper Klamath Basin is generally consistent with the stated goals or objectives of federal and state resource managers, and with a long-range plan for restoring Klamath Basin fisheries that a multiparty task force completed under authority of a law passed by the U.S. Congress in 1986 (P.L. 99-552; the Klamath Act). For example, federal and state policies require that under most circumstances, safe and effective up- and downstream fish passage be provided at or around dams, including those originally constructed without functional passage facilities. Consistent with these policies, the fishery restoration plan developed by the Klamath River Basin Fisheries Task Force, mentioned above, includes identifying and implementing solutions to fish passage and water quality problems associated with the KHP as an important objective (USFWS 1991).
>
> More recently, Oregon has adopted a Native Fish Conservation Policy that provides statewide management goals intended to ensure the conservation and recovery of native fish (ODFW 2003). This policy places emphasis on restoring and maintaining native fish at population levels that provide ecological and societal benefits, but has yet to be fully incorporated into Oregon's Klamath River Basin Fish Management Plan (ODFW 1997), which will be undergoing a 10-year update soon (R. Smith, ODFW, pers comm.; A. Stuart, ODFW, pers comm.). Oregon's existing basin plan takes a precautionary view of anadromous fish reintroductions, emphasizing the need to consider the uncertainties or potential risks of such an effort, as well as the potential benefits. California's policies on the management of native fish in the Klamath Basin are not inconsistent with those of Oregon.

(6) Protected river status (e.g., scenic river, wilderness area);

The Klamath River from below Iron Gate Dam to the mouth of the River 190 miles downstream was federally designated as Wild and Scenic (Recreational classification) based on its outstanding fisheries values in 1981. The mainstem reach between the Copco reservoir and the Oregon border is designated by the State of California as a Wild Trout Area, and the 11 mile reach between the California Oregon border to the J. C. Boyle powerhouse is designated as Wild and Scenic. The Wild and Scenic Rivers Act, requires

[18] Huntington et al 2006
[19] Huntington et al 2006

federal agencies to administer and manage the Klamath River area and adjacent lands to "protect and enhance" its outstandingly remarkable values, namely, the river's anadromous fishery.

(7) Effectiveness of past mitigation measures and availability of future measures;

We provide detailed comments on this subject later in this document. This is a summary.

Under the original license the FERC stipulated mitigation for the impacts to anadromous fish habitat lost only from the reach between Iron Gate Dam and Copco II, a seven mile long reach of the River, even though all dams in the system from Iron Gate to up to Link (including Copco I, Copco II, J C Boyle, Keno, and Fall Creek dams were included in the license; Dams which by their construction blocked or inundated approximately 300 miles of anadromous fish habitat.

The Iron Gate Hatchery below Iron Gate Dam was constructed to mitigate for the anadromous habitat lost between Iron Gate and Copco Reservoirs. While it is currently meeting the goals for fall-run Chinook and coho salmon established in the 1960s it is not meeting the goals established for steelhead trout, and spring-run Chinook. An outstanding fault of the original mitigation agreement was that it did not consider mitigation for the loss of spring Chinook salmon, a race which was undoubtedly a major component of anadromous runs into the Upper Klamath Basin. While remnant runs returned to the base of the dam from 1962 through 1974, and the hatchery attempted artificial propagation in 1968, efforts to conserve the population failed. Spring Chinook are now extinct in the Project area, and are in large part, limited to the Salmon River 130 miles below Iron Gate Dam. Prior to project construction, spring Chinook were a primary ocean and in river fishery target species. Near elimination of spring Chinook in the Klamath River Basin, and declines of other salmon species, have substantially impacted River and coastal communities which depend on fishing for commercial, recreational, and tribal subsistence purposes. The spring Chinook run can be reestablished by dam removal.

As noted previously, FERC assumed that the construction of Iron Gate Dam and the Iron Gate Hatchery would "restore the downstream reaches to the condition which existed prior to [the construction of Copco I in] 1918."[20] This did not happen.

With regard to water quality, the only mitigation that PacifiCorp has proposed is an oxygenation system that would have unknown effects on lake turnover and thus nutrient input to the lower river. The proposed mitigation would only fix the immediate effects of low oxygen releases in the vicinity of Iron Gate Dam, and would do nothing to fix the dissolved oxygen problems that exist further downstream as a result of nutrient enrichment. PacifiCorp has not

[20] FERC Opinion (#381) and Order on Petition to Construct Fish Hatchery. March 14,1963

proposed any mitigation for nutrient enrichment of lower river environments nor for blue-green algae that finds its way downstream.

PacifiCorp has stated that it believes that its considerable temperature effects cannot be mitigated. We agree, but the problem must be addressed in some manner. We believe that the only way that the problem can be addressed is through decommissioning.

(8) Support by applicant or other party for decommissioning;

PacifiCorp has made it abundantly clear that they will not consider any dam removal options in their license application. Virtually all Agencies, Tribes, and other major stakeholders have requested that the information and analysis of dam removal options be provided to inform the process, and many stakeholders have recommended, based on the record so far, the removal take place. Department of Interior, the State of California, and the state of Oregon have all expressed support for including decommissioning as a viable project alternative.

In its review of Klamath water management practices and the science that guides those practices, the National Research Council[21] recommended that a look be given to the removal of at least some of the facilities in the KHP.

(9) Tribal lands, resources, or interests;

FERC "recognizes the unique relationship between the United States and Indian tribes as defined by treaties, statutes, and judicial decisions. The Commission also acknowledges that, as an independent agency of the federal government, it has a trust responsibility to Indian tribes and this historic relationship requires it to adhere to certain fiduciary standards in its dealings with Indian tribes."[22]

"The Tribes' rights include the right to certain conditions of water quality and flow to support all life stages of fish." See United States v. Anderson, 591 F. Supp. At 5-6; see also United States v. Gila Valley Irrigation District, 804 F. Supp. At 7.[23] These conditions for water quality apply to the rights of both the Klamath Tribes of the Upper Basin and the Tribes of the Klamath River below Iron Gate Dam.

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[21] National Research Council (NRC). 2004. Endangered and Threatened Fishes in the Klamath River Basin - Causes of Decline and Strategies for Recovery. Report by the National Academy of Sciences' Committee on Threatened and Endangered Fishes of the Klamath River Basin. National Academies Press, Washington, D. C. 397 p.

[22] FERC Policy Statement on Consultation with Indian Tribes in Commission Proceedings (July 23, 2003)

[23] United States Department of the Solicitor. Certain Legal Rights and Obligations Related to the U.s. Bureau of Reclamation, Klamath Project for use in Preparation of the Klamath Project Operations Plan. July 25, 1995

In the EIS FERC will be required to analyze the environmental effects of each alternative on Indian Tribes and tribal lands, trust resources and interests. "This analysis will include a discussion of how effects to specific resources (e.g., fisheries, cultural resources) will affect the Tribe[s]."[24]

(10) Water quality issues, including presence of toxic sediments:

Degraded water quality is an issue throughout the mainstem reach of the Klamath River. The considerable impacts that the KHP has to water quality are discussed later in this document. However, to summarize, PacifiCorp has large effects to water quality of which it has offered little or no mitigation.

Regarding Sediment:

Total sediment volume and any issues of toxicity are being evaluated at this moment in consideration of dam removal options. Sediment deposition studies will include collection of sediment samples from Project reservoirs to determine particle size distribution of sediment, and toxicity if any, being trapped behind the dams. Total sediment volume and annual average loading rates will be calculated for each reservoir by comparing the present day bathymetry to that of pre-inundation. Similarly, component sediment volume and component average annual loading rates will be calculated for each reservoir by incorporating the particle size distribution data.

This will greatly assist FERC in its analysis of dam decommissioning options for the KHP.

(11) Potential opportunities for recreation;

The FLA contains sufficient discussion of existing recreational opportunities within the Project boundaries, but PacifiCorp has not provided an analysis of the potential socioeconomic benefits to the area were anadromous fish runs to be reestablished throughout their historic habitat. As stated previously, in the *Interagency Task Force Report on NEPA Procedures in FERC Hydroelectric Licensing* it is stated that in "deciding whether or under what conditions to relicense a project, FERC can consider both past and present (or continuing) effects, including those attributable to the project since its construction, in determining what conditions may be appropriate for the new license term."

Finally, we turn to the recreational value of the reservoirs themselves. Recent information has dramatically lessened the value of these reservoirs to summer recreational users. *Microcystis*, a species of blue-green algae with highly toxic properties, has been discovered in extremely high concentrations in project reservoirs. Siskiyou County has posted warnings to recreational users, but the concentrations of the algae are such that it is highly possible that the reservoirs will have to be closed to human contact for significant

[24] Interagency Task Force Report on NEPA Procedures in FERC Hydroelectric Licensing.

portions of the year, primarily during the warm season. PacifiCorp has proposed no mitigation for this serious problem.

(12) Physical condition of project;

Should the project be granted a new license for a 50 year term, the oldest (Copco I) will be to 138 years old, and the newest (Iron Gate) will be 94 years old. Many major parts of the project are nearing, or will exceed their engineering life expectancy. The Tribe, located downstream from the KHP, has significant concerns about the safety of the project, given its age.

The Yurok Tribe believes that the age of the projects is a factor that should contribute to FERC's denial of a new license.

(13) Presence of existing project-dependent development (e.g., houses abutting reservoir);

There are houses along the shoreline of Copco Reservoir. However, as mentioned in more detail elsewhere in this document, the presence of large concentrations of toxic algae is a new emerging factor in the valuation of these residences. In the event that the reservoir needs to be closed to human contact, property values on the lake are likely to fall. Indeed, right now there are reports of homeowners who have lost pets because the pets drank water from PacifiCorp reservoirs.

(14) Other non-power project-related benefits (e.g., municipal water supply, flood control, irrigation);

<u>Irrigation:</u> Although a hydroelectric project reservoir, the Keno reservoir located just downstream of Upper Klamath Lake has 91 water diversion points off the reservoir. However, the Yurok Tribe is not calling for the decommissioning of this dam.

<u>Municipal Water Supply:</u> The City of Yreka has a 1966 California water right of 15 cfs to divert water from Fall Creek for its municipal water supply. The city maintains and operates two diversions in Fall Creek. However, the Yurok Tribe is not calling for the decommissioning of this dam.

<u>Flood Control:</u> PacifiCorp's hydroelectric project does not provide flood control for areas below the Dams. As per the DLA "The potential for high run-off conditions occurs each year from approximately November through April. Since the Project reservoirs contain so little active storage, UKL provides the only meaningful storage in the basin to ameliorate high flow events." (Exhibit B at 2-7).

Indeed, the Yurok Tribe believes that the presence of the dams upstream <u>increases</u> flood risk. Recent upgrades to the emergency outlet tunnel to repair a non-functioning emergency drain, and the addition of 7 extra feet to the top of the dam after flood frequency was updated as a result of the 1997 flood demonstrate to the Tribe that the Project has not been as safe as it should have been for the past few decades.

<u>Power Subsidies:</u> Link River Dam was constructed as a result of a 1917 agreement between PacifiCorp's predecessors, Copco, and the Bureau of Reclamation to regulate flows out of Upper Klamath Lake for hydropower and irrigation. This agreement gave Copco significant flexibility in operating the dam for hydropower generation. Special contract rates for the Bureau's project irrigators were included in the agreement.

The contract agreement, and the subsidized power rates for irrigation that it includes, are due to expire in 2006 concurrent with the expiration of PacifiCorp's hydropower license. PacifiCorp contends that the contract is not a component of the FERC process and as such the ramifications of the expiration of that contract do not need to be included in the License Application.

(15) Project-dependent resource values (e.g., recreation, wetlands, wildlife, habitat);

Although the project provides for a limited amount of recreational opportunities in its reservoirs, we believe that the presence of the toxic blue green algae negates the benefits of such features. For example, it is likely that toxins in the reservoir water are negatively impacting wildlife species. In any case, we believe that decommissioning would offer a net benefit to nearly all wildlife species.

(16) Need for power and ancillary services;

"If generation were to cease at the Klamath Project, PacifiCorp would still be able to service its local customers. Non-Project substations would remain available to supply power throughout the Project area." (Exhibit H at 2-7)

In discussions of Energy and Cost Implications of License Denial (Exhibit H) PacifiCorp make no reference to new 500MW co-generation facility in Klamath Falls, or other proposed local facilities.

The California Energy Commission staff completed a preliminary electricity analysis of the possible decommissioning of one or more dams in the PacifiCorp Klamath Hydroelectric Project. The staff's assessment indicated that:

> "…from the perspective of potential impacts to electric resource adequacy, decommissioning is a viable alternative that should be examined during the Federal Energy Regulatory Commission (FERC) proceedings on renewal of the hydroelectric license for these facilities.[25]

In compliance with FPA requirements, FERC must give equal consideration to the purposes of energy conservation, the protection, mitigation of damage to, and

[25] California Energy Commission. Preliminary Assessment of Energy Issues Associated with the Klamath Hydroelectric Project. April 28, 2003

enhancement of fish and wildlife (including related spawning grounds and habitat), the protection of recreational opportunities, and the preservation of other aspects of environmental quality. At question is the basic best beneficial use of the natural aquatic resources of the Klamath River and whether the potential benefits of an improved ecosystem outweigh those derived from the limited power production of the hydroelectric project.

(17) Historic Properties

During the relicensing process PacifiCorp and the FERC must consider the Tribes' fisheries trust resources in the dual context of protection as a trust resource and protection as a cultural resource. For the Yurok Tribe, robust and diverse fish runs represent not only economic wealth, but an integral part of a living culture.

PacifiCorp acting as the agent for FERC under the Historic Preservation Act 106 must take into account the effect of its actions on traditional cultural properties. The Tribes have requested an assessment on the eligibility of the Klamath River corridor and Upper Klamath Lake and its headwaters in the National Register as a traditional cultural landscape. And, as required to provide information on the impacts to that landscape from project operations with consideration that trust species are contributing elements to the Landscape. PacifiCorp has agreed to allow the Tribes to submit a "White Paper" on the Traditional Cultural Landscape for inclusion into the License Application, PacifiCorp will not assume their responsibility to assess the landscape as to its eligibility for the National Register.

Detailed Justification for Decommissioning Recommendation Organized by Specific Impacts

The following section contains detailed rationale for the Yurok Tribe's recommendation for the removal of the lower four dams in the KHP. For each major impact of the KHP, we summarize PacifiCorp's proposed protection, mitigation and enhancement measures, describe KHP affects to the Klamath River and the Tribes resources, and reiterate the Yurok Tribe's recommendation.

Data sources for the following section are incorporated into a "References Cited" section at the rear of the document.

FISH PASSAGE

For the sake of clarity, we divide this section into two sections; one of which deals with fish passage directly, and the next which deals with PacifiCorp's mitigation for fish passage impacts (Iron Gate Hatchery).

PacifiCorp proposed mitigation

None.[26]

Yurok Tribe Recommendation

The most effective passage alternative would be for the removal of the lower four facilities in the KHP (JC Boyle, Copco 1 and 2, and Iron Gate Dam). Volitional passage could be effective for certain species and runs, but is unlikely to effectively mitigate for Pacific lamprey, and is likely to pose challenges to ocean-type fall Chinook salmon recolonizing areas of the Upper Sprague River (Hamilton et al 2005).

Justification

There are no fish passage facilities at Iron Gate Dam, Copco 1 or Copco 2. JC Boyle has passage facilities of questionable effectiveness. PacifiCorp has attempted to mitigate for the lack of passage through the operation of Iron Gate Hatchery. However, Iron Gate Hatchery has been a failure in several important respects.

Spring Chinook

Spring Chinook were present in the Upper Klamath Basin (Hamilton et al 2005), and current habitat conditions would once again support runs (Huntington et al 2006). After the construction of Copco Dam in 1918, spring Chinook salmon persisted in the Klamath River immediately below the project, but when Iron Gate Dam was constructed in the 1960's the run ceased to exist soon after. Thus, no mitigation has been attempted for the loss of this important run of fish, and none is proposed by PacifiCorp.

Steelhead

Steelhead were also present in the Upper Basin (Hamilton et al 2005). Recent returns to Iron Gate Hatchery have been extremely low (in some cases under 10 fish), and scale analysis of the returning adult fish have shown that many have not gone to the ocean. Thus, the mitigation for the lack of steelhead passage has been a failure.

Pacific Lamprey

Pacific lamprey once returned to habitats above Iron Gate Dam (Hamilton et al 2005). PacifiCorp has proposed no mitigation for the loss of passage for this important species. Tribal members utilize this fish, which is an important part of the Yurok Tribe's fishery trust resources.

ARTIFICIAL PROPAGATION

[26] PacifiCorp proposes to continue operation of Iron Gate Hatchery under current management practices, which is discussed more fully in the next section.

PacifiCorp proposed mitigation

1. PacifiCorp proposes to fund 80 percent of the production and operation costs of the Iron Gate Hatchery to meet current production goals.
2. PacifiCorp proposes to purchase/construct facilities and provide the necessary equipment to expand the marking and tagging of fall Chinook smolts produced at the Iron Gate Hatchery from the current five percent rate to 25 percent. The proposal includes the purchase of a mass marking system for use at the hatchery.

Yurok Tribe Recommendation

PacifiCorp should fund all artificial propagation efforts necessary to restore anadromous fish to historic habitats above the current location of Iron Gate Dam, in addition to artificial propagation necessary to mitigate the ongoing impacts of the KHP once the dams are removed, as the river goes through the recovery process.

Until the river is recovered from the impact of the dams, mitigation efforts should continue for fall Chinook, spring Chinook, steelhead, and coho salmon. Initially, reintroduction hatcheries should only be operated for fall Chinook, spring Chinook, and coho salmon, with consideration also given for lamprey. Efforts to reintroduce steelhead should follow a wait-study-and-see approach for a number of years to determine whether: 1) coastal steelhead begin colonizing the area naturally, 2) redbands from the upper basin begin expressing anadromy, or 3) improved understanding is developed of a coastal steelhead niche in the Upper Basin.

Hatcheries necessary for reintroduction efforts should not be limited to Iron Gate Hatchery, but include facilities within what is currently the KHP (e.g. Fall Creek), as well as above Upper Klamath Lake. Use may be made of existing facilities such as Fall Creek Hatchery, Crooked Creek Hatchery and the Klamath Tribes facility at Bray Mill on the lower Sprague River. Consideration should also be given to temporary hatch box type facilities in conjunction with small rearing facilities.

We recommend that a technical team of experts from Tribes, as well as State, and Federal agencies be formed to best determine the production goals, locations for hatchery facilities, and overall guidance regarding the propagation techniques utilized for the reintroduction of anadromous fish to the Upper Basin, as well as mitigation for ongoing impacts. Reintroduction efforts should be implemented following an adaptive management process to ensure that adequate monitoring and the best available scientific techniques are followed to allow for successful long-term reintroduction, while minimizing effects to existing natural stocks. Deference should be given to developing stocks that are genetically fit to survive over the long-term, rather than simply producing large numbers of returning fish in the short-term.

We support PacifiCorp's proposal to tag 25% of fall Chinook smolts that are produced by artificial propagation and recommended that this be expanded to fall Chinook sub-yearlings as well as all spring Chinook that are produced by future hatchery efforts.

Justification

Currently, Iron Gate Hatchery attempts to mitigate for fall Chinook, coho salmon, and steelhead production that was lost by the construction of Iron Gate Dam; only the stretch of river between Iron Gate Dam and Copco 2. There is no effort to mitigate for spring Chinook from this reach of the river, nor for the lost production of all the species that once inhabited areas above Copco 2. Furthermore, efforts to mitigate for steelhead have been abysmal at best, with some years resulting in extremely small numbers of steelhead returning to the hatchery. There has never been any effort to mitigate for lamprey that once inhabited areas above Iron Gate Dam.

The loss of species that once inhabited the areas above Iron Gate Dam has had devastating impacts upon Yurok People, not only because of the lost production that is no longer harvestable, but because of the temporal void in availability of fish. Spring Chinook from the Upper Basin were at one time one of the most abundant runs of fish available for Yurok People; however this changed dramatically with the construction of Copco dam in 1917 and was further exacerbated by the construction of Iron Gate Dam in the early 1960's. The loss of these fish has limited the primary Yurok fishery to approximately a 1.5 month time-period in the fall, rather than having healthy populations migrating through the reservation throughout most of the year.

The Tribes have been deprived of these important fisheries resources for much too long, and the stocks that once inhabited areas above Iron Gate Dam have been extirpated. Therefore, measured artificial propagation is necessary to initiate reintroduction to the Upper Basin as soon as volitional passage is provided, as well as to ensure that the best available source of brood stock is used to re-colonize these areas. Furthermore, given that impacts of the dams will remain for some period of time after their removal, mitigation for these impacts should be provided until the river recovers.

TEMPERATURE

PacifiCorp proposed mitigation

None.

In response to FERC's AR-1 request, PacifiCorp used its water quality model to analyze various possible ways to reduce the KHP's effects on temperature. PacifiCorp (Scott 2005) summarized its findings as follows:

> "The results of the analyses indicate that potential reservoir water temperature management using selective withdrawals, curtains, or flow augmentation offers only modest, if any, improvements to water temperatures in the Klamath River downstream of Iron Gate dam. Furthermore, the alternatives examined do not provide appreciable differences in regard to their relative effect on fish."

FERC then requested PacifiCorp to complete additional modeling regarding selective withdrawal options. PacifiCorp's (2005b) subsequent investigations showed that the measured outcome would be ineffective in mitigating project impacts:

> Based on these results, PacifiCorp concludes that the additional revised selective withdrawal scenarios do not provide effective control of temperatures below Iron Gate dam, and therefore do not merit more detailed design evaluation under Part (b) of this AIR.

Furthermore, PacifiCorp wrote (PacifiCorp 2005b)

> "Consideration was given to turning the lake over earlier through implementing selective withdrawal earlier in the season. However, concerns over mixing nutrient rich bottom waters into the photic zone and possibly creating beneficial conditions for primary production was deemed undesirable."

Yurok Tribe Recommendation

PacifiCorp's own analyses make it clear that the KHP's effects on water temperature are immitigable; therefore, the only way to substantially reduce the impacts is to remove Iron Gate, Copco I, Copco II, and J.C. Boyle dams.

Justification/Project Effects

It is widely recognized that the KHP alters water temperatures in the Klamath River (PacifiCorp 2004). Due to the thermal mass of Iron Gate and Copco reservoirs, water temperatures in the mainstem Klamath below Iron Gate Dam are cooler in spring, and warmer in late summer and fall, than would exist if the KHP were absent (PacifiCorp 2004, PacifiCorp 2005, Deas 2004). In the Klamath River near Iron Gate Dam, the KHP decreases daily average water temperature in the spring and early summer by at least 5° C and it also increases stream temperatures in late summer and autumn by at least 5° C (Figure 5). Due to variations in weather, the timing and magnitude of these temperature deviations will vary from year to year.

The document entitled *EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards* (U.S. EPA 2003) recommends temperature limits for various life history stages for the protection of Pacific salmon species. For spawning, U.S. EPA recommends that the maximum seven day floating average (7DADM) not exceed 13° C, which is shown on Figure 1 as a reference line. Model outputs in Figure 5 show that the Klamath River water temperature without the KHP would begin to fall to lower than 13° C for at least brief periods, as early the first week in September. Natural temperatures would consistently meet U.S. EPA thresholds (13 C 7DADM) three weeks earlier than temperature of flows currently emanating from Iron Gate Dam. Eggs laid in the Klamath River below Iron Gate at higher than optimal conditions are likely to have higher pre-hatch mortality, a greater rate of developmental abnormalities, and lower weight as alevins (McCullough 1999).

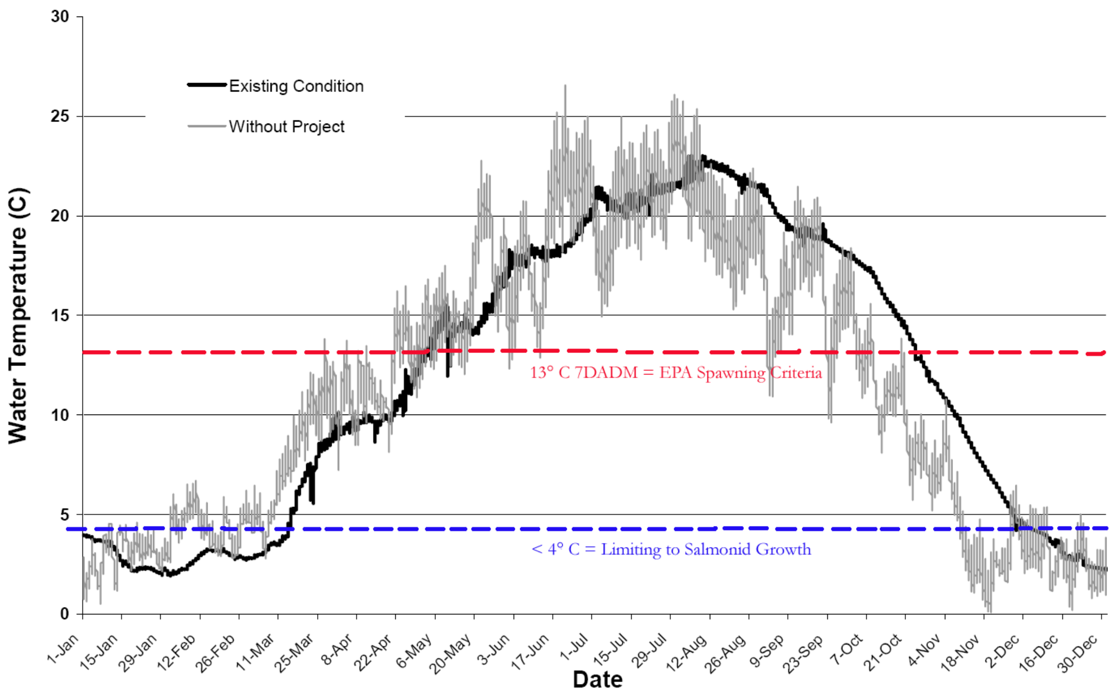

Figure 1. PacifiCorp water quality modeling output showing water temperatures at Iron Gate Dam for the year 2000, comparing existing condition (with project) and without project scenarios (PacifiCorp 2005c). References for salmonid spawning and the lower limit for salmonid growth are from U.S. EPA (2003).

The U.S. EPA (2003) and McCullough (1999) both recognize 4° C as the lower temperature lower limit for salmonid growth. While Klamath River flows would naturally drop below 4° C in December and January, they would sometimes rise above that level during that period whereas reservoir outlet flows stay consistently below it. Also, with project flows remaining under 4° C early December to late March, where without project temperatures would exceed that threshold consistently starting in February (Figure 1).

Warm incubation temperatures accelerates time of emergence. Therefore, it is likely that Klamath River fall chinook fry emerge from the gravel earlier than they would if incubation temperatures were optimal throughout their gestation. Early emerging fry then have to withstand suboptimal stream temperatures as a result of KHP-depressed stream temperatures through late March. Chinook salmon juveniles in the Klamath River that are small in size migrate downstream slowly (PFMC 1994). Increased residence time in the mainstem exposes fish to prolonged stress, increasing their likelihood of becoming infected with parasites (see Fish Disease section below). In addition, the larger a smolt is before entering the ocean, the higher its chances of surviving to maturity and returning to spawn, therefore the reduced size of Klamath River smolts as a result of the cooler spring temperatures caused by the KHP ultimately decreases survival. (Nicholas and Hankin 1988).

Iron Gate Dam forms a complete barrier and prevents anadromous salmonids from migrating upstream. In the J.C. Boyle Bypass Reach, located between Copco and Keno Reservoirs, there are springs that contribute approximately 225 cubic feet per second of clean, cool water. These springs could be among the most significant thermal refugia on the entire mainstem of the Klamath River and there is evidence they were supporting summer holding by spring-run chinook prior to the construction of Iron gate Dam. Spring-run chinook were historically the most abundant salmonid species in the Klamath Basin, but blockage of migration and deterioration of habitat has extirpated them from the majority of the basin, and irrefutably in the project reach. The U.S. EPA (2003) points out that access to refugia is essential for river systems where attainment of optimal mainstem temperatures is not possible. The critical role of thermal refugia in maintaining the viability of anadromous salmonids in the Klamath Basin has become increasingly clear in recent years (Belchik 1997, McIntosh and Li 1998, Watershed Sciences 2002).

FISH DISEASES

PacifiCorp proposed mitigation

PacifiCorp has not proposed any measures to mitigate the project's effects on fish parasites.

Yurok Tribe Recommendation

Removal of KHP dams would reverse the KHP effects described above, including reversing the KHP-driven expansion of habitat for *C. shasta*'s polychaete host *M. speciosa* by reducing the amount of organic matter and *Cladophora* in the Klamath River. With dam removal or provision of fish passage, the salmon would likely distribute salmon spawning over a larger area, reducing *C. Shasta* spore counts. Dam removal would also improve water temperature, pH, dissolved oxygen, and ammonia levels, which would reduce salmonid stress and hence help restore salmonid immune systems.

For these reasons, it is likely that dam removal would contribute to enhanced fish health and lower the rate of myxosporean parasite infection and disease in Klamath River salmonids. FERC should specify in any new license for the KHP that project dams should be removed from the Klamath River as quickly as is practicable.

Justification/Project Effects

Background information

In recent years, myxozoan parasites have received increasing attention in the Klamath River, especially for their role in causing fish kills of juvenile salmonids. The two that have been most closely studied are *Ceratomyxa shasta* and secondarily *Parvicapsula minibicornis*. The life cycle of *C. shasta* utilizes two different hosts- the freshwater polychaete worm *Manaynukia speciosa* and a salmonid. A summary of the life cycle is provided in Stocking and Bartholomew (2004) with details described in Bartholomew et al. (1997). *C. shasta* myxospores develop in the salmonid, which are then released to infect the polychaete; in the polychaete, actinospores develop and when released they can infect salmonids (Figure 17). Bartholomew (2006) recently discovered that *Parvicapsula minibicornis* also uses the same polychaete host.

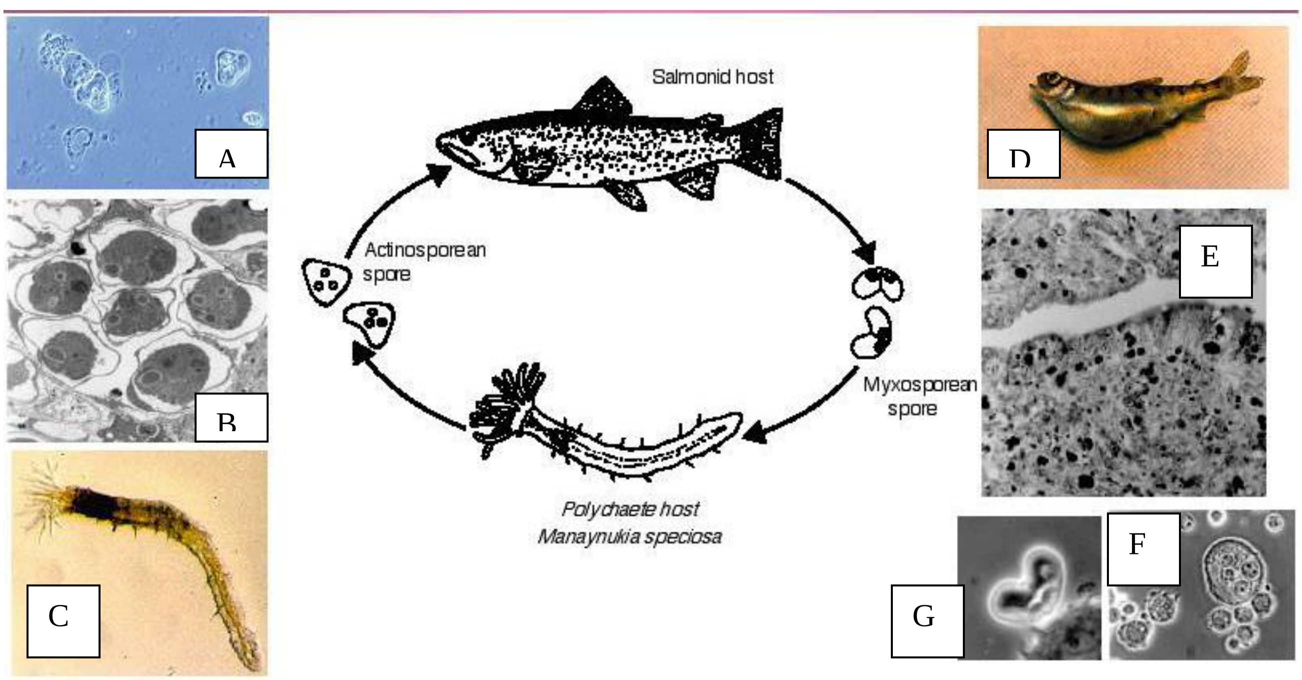

Figure 17. Life cycle of *Ceratomyxa shasta* showing release of the myxospore stage from the infected fish, the polychaete alternate host, and release of the alternate actinospore stage from the polychaete. A. released actinospores, B. electron micrograph of actinospores in the

polychaete, C. polychaete, D. infected fish, E. histological section of infected intestine, F. trophozoite stages, G. myxospore (Bartholomew et al. 1997).

Existing conditions in the Klamath River

C. Shasta was first detected in the Klamath River in the 1980s (Hendrickson 1989) and was first identified as being a serious fish health issue in 1995 (Foott et al. 1999). The recent high incidence of *C. Shasta* in the Klamath River may be due to an increase in polychaete populations caused by an increase in polychaete habitat (Stocking and Bartholomew, 2004).

Unpublished data from recent surveys on the Klamath River have shown that the polychaete's primary habitat is sand with fine benthic organic matter (Stocking 2006). Its secondary habitat is dense beds of *Cladophora*, a filamentous green algal species. There are some notable differences between these two habitats. Polychaetes living on the sand with fine benthic organic matter substrate are restricted to low-velocity areas, whereas polychaetes can exist in *Cladophora* in areas with higher water velocities (Stocking 2006). In addition, sand with fine benthic organic matter is a less stable substrate than *Cladophora*. For instance, Stocking (2006) sampled an extremely large and dense population of polychaetes at Tree of Heaven (approximate river mile 170) in March 2005. When Stocking returned to sample again in July after a high-flow event (discharge below Iron Gate Dam peaked at 5380 cubic feet per second on May 18), much of the organic matter was gone and all polychaetes had disappeared (presumably both had been washed downstream). In contrast, polychaete populations in *Cladophora* beds remained intact.

To date, there has been no systematic effort to map the distribution and abundance of *Cladophora* in the Klamath River and its tributaries. *Cladophora* distribution in the Klamath River appears to be patchy. When present it often covers large areas with a dense mat (Stocking, pers. comm.). Stocking (pers. comm.) says that *Cladophora* is most common between Iron Gate (river mile 190) and Happy Camp (approximate river mile 100), and he has not seen it downstream of the Klamath's confluence with the Trinity (river mile 44).

A recent unpublished study examined the rates of C. *shasta* and *P. minibicornis* infectivity in their polychaete host *M. speciosa* at many Klamath River sites from near the outlet of Upper Klamath Lake to China Point near Happy Camp (Stocking 2006). The study found that in the year 2005, the sites with highest *C. shasta* infection prevalence in polychaetes were the Tree of Heaven (approximately river mile 170) and Interstate 5 (approximately river mile 179). The most likely explanation for this high infection prevalence at these sites is their proximity to the salmon spawning grounds below Iron Gate Dam (Bartholomew and Stocking, pers. comm.). Returning adult salmon can become infected with *C. shasta* as they move upriver. When they spawn and die, the *C. shasta* myxospores contained inside them are released and can infect polychaetes.

Ceratomyxa shasta causes major problems for the health of juvenile salmonids in the Klamath River. *C. Shasta* infection rates are extremely high and in many years results in the death of significant portion of the juvenile salmonids in the Klamath River. Nichols and Foott (2005) estimated that in 2004, 45% of juvenile fall-run chinook salmon were infected with *C. Shasta*, 94% of the population was infected with *P. minibicornis*. Histological examination of infected fish revealed that tissue damage was extensive suggesting that mortality was likely to occur in these fish.

Hallet et al. (2006) found that *C. shasta* parasite densities in water samples below Iron Gate Dam was several orders of magnitude greater than above. We now know that resistance to *C. shasta* can be overwhelmed by prolonged exposure to the parasite or by high infectious dose (Ratliff 1981, Ibarra et al. 1992). Exposures conducted in June 2004 revealed that Iron Gate Hatchery fall Chinook salmon are resistant to the parasite densities above Iron Gate Dam, but that resistance was overwhelmed below (Stocking et al. 2006). The density threshold at which these fish succumb to infection is not known but is under investigation.

In a recent unpublished study, the Karuk Tribe collected water samples biweekly (once every two weeks) at many sites between Iron Gate Dam and the Klamath estuary from May through September (Bartholomew 2006). A technique known as QPCR was used to quantify the amount of C. Shasta DNA in the water samples. Known quantities of C. Shasta spores were also processed with QPCR, which allows development of quantitative relationship between QPCR results and the number of spores in a sample. The biological significance (to fish) of specific spore concentrations is still unknown at this time, but this knowledge will be developed over time by performing QPCR on water samples in the same locations as sentinel fish studies are being conducted. Even in the absence of accurate knowledge of the biological significance of spore counts, knowing spore counts is still useful because it allows comparison of the relative exposure risk between sites and time periods.

Unpublished preliminary analyses of the 2005 QPCR sampling results suggested some trends (Bartholomew 2006). Spore counts were generally highest in June and July, except for sites downstream of the Trinity River where there were never many spores detected at any time during the season. The longitudinal pattern was that spore counts were low at the site immediately below Iron Gate, then increased to very high levels (approximately 10-20 spores/L) at the Klamath River above the Shasta, and then decreased as water flowed downstream past each successive monitoring station. Spore concentrations remained relatively high until downstream of Seiad Valley (concentrations were relatively high at Klamath River above the Scott and the Klamath River at Seiad Valley).

To reduce fish stress and the incidence of *C. Shasta* infection in the Klamath River, it may be insufficient to improve physical water quality variables such as temperature, pH and D.O. It also may require a reduction in parasite loads. Reducing parasite densities could likely be achieved by reducing populations of the polychaete host. This could likely be achieved by reducing available habitat for the polychaete. Decreasing the amount of organic matter in the Klamath River would reduce the amount of the polychaete's primary habitat (sand with fine benthic organic matter). As explained above in the Periphyton section, green algae such as *Cladophora* are more common in streams with high nutrient concentrations, so reducing the amount of nutrients in the Klamath River would likely lead to a reduction in the amount of *Cladophora* (the polychaete's secondary habitat).

Project effects

As described below, the KHP may have promoted myxosporean parasite proliferation in the Lower Klamath River by altering nutrient dynamics, increasing habitat for the polychaete *M. speciosa*, and increasing *C. shasta* infection rates of *M. speciosa* populations below Iron Gate Dam. In addition, through its effects on nutrient dynamics, the KHP deteriorates pH / D.O. conditions and increases ammonia, causing stress and immunosuppression in salmonids, increasing the likelihood that they will become infected and diseased.

It has been documented that the reservoirs can periodically release pulses of organic matter downstream (Kann and Asarian 2005). When this organic matter settles in depositional zones of the Klamath River, it provides habitat for *M. speciosa*. An increase of abundance for the polychaete host can potentially lead to an increase in abundance of the parasite.

Biggs (2000) notes that reservoirs (such as Iron Gate) disrupt downstream transport of gravel, leading to substrate coarsening and armoring of the streambed, which favors the establishment of green filamentous algae such as *Cladophora*. This likely contributes to larger populations of *C. shasta*'s polychaete host *M. speciosa* by expanding the quantity of its secondary habitat (*Cladophora* beds). This likely contributes to higher polychaete populations, higher *C. shasta* actinospore loads in the water column, *C. shasta* infection in salmonids, and hence salmonid disease and death.

Removal of the dams would likely decrease *C. shasta* infection rates in *M. speciosa* polychaetes for two reasons.

First, the Iron Gate and Copco reservoirs have decreased the amount of spawning habitat available to anadromous salmonids because Iron Gate (river mile 190) is a complete barrier fish passage, and because Iron Gate and Copco Reservoirs flooded many miles of high-quality spawning habitat. This contributes to massive aggregations of spawning fish in the mainstem Klamath River below the dam (Figure 2). As noted above, the highest rates of *C. shasta* infection in polychaetes were found at Tree of Heaven (approximately river mile 170) and Interstate 5 (approximately river mile 179). These high infection rates may be due to Iron Gate Dam causing a blockage in salmon migration, as well as the impoundment of spawning habitat under the reservoirs. If the dams were removed the salmon would likely spawn over a more dispersed area, and there would not be concentrated release of *C. shasta* myxospores that occurs with the spawning and death of thousands of salmon in a relatively small area.

Second, as described above, the KHP has moved the “recovery zone” of high periphyton productivity downstream so that it overlaps with the high-quality salmon spawning habitat below Iron Gate Dam. This means that salmonids are spawning in close proximity to the *M. speciosa* polychaetes that live on *Cladophora* (a green algal species common in the recovery zone), increasing chances that the *C. shasta* myxospores will infect polychaetes when the salmon die after spawning and release them. If the dams were removed, the recovery zone would move upstream, so most of the *Cladophora* would exist upstream of the Iron Gate / Copco spawning grounds, hence when spawning salmon died and released their *C. Shasta* myxospores, those myxospores would be released *downstream* of where the *Cladophora* (and its attendant polychaetes) would be concentrated, leading to lower infections rates of polychaetes by *C. shasta.*

As discussed above in the Temperature, pH, Dissolved Oxygen, and Ammonia Toxicity sections above, the KHP is detrimental to physical and chemical water quality, which contributes to fish stress and immunosuppression, increasing chances of infection and disease.

The upstream ends of KHP reservoirs have some of the largest populations of polychaetes discovered in the Klamath system (Stocking 2006). Polychaetes were rarely found in other portions of the reservoirs suggesting that optimal living conditions for the polychaete exist at the inflow and/or water quality in the deeper portions of the reservoir may be a limiting factor (Stocking, pers. comm.). On extreme high-flow events, polychaetes could potentially be flushed from the upper ends of the reservoirs into the river below, though it is unknown if this occurs.

NUTRIENTS

PacifiCorp proposed mitigation

None

Yurok Tribe Recommendation

Dam removal would reverse deleterious KHP effects on nutrient dynamics by restoring natural river processes.

Justification/Project Effects

Project operations are delaying water quality recovery. Water quality in the Klamath River should improve naturally as it flows downstream, due to freshwater inflows, the capacity of the system to assimilate nutrients, reduced inputs through TMDL implementation, and restored adequate flow regimes.

PacifiCorp's (2004) Final License Application presented limited analysis of water quality data; however, some important details were obscured by averaging data over broad spatial and temporal scales. They postulated that retention of organic matter and nutrients in the reservoirs results in a net decrease in organic matter and nutrients that would otherwise continue downstream (PacifiCorp 2004).

Kann and Asarian (2005) used water quality data collected by PacifiCorp and the U.S. Fish and Wildlife Service to calculate nutrient budgets for Copco and Iron Gate Reservoirs. The report concludes:

> "These preliminary analyses indicate that for the Copco/Iron Gate Reservoir system, the April-November period is characterized by periods of positive and negative retention for both phosphorus and nitrogen (net positive values denote a sink and net negative values denote a source). Despite acting as net sinks for P and N over the entire Apr-Nov period, both Copco and Iron Gate Reservoirs can act as a nutrient source during critical periods (e.g., June through September), making nutrients available at such periods for downstream growth of algae and macrophytes.
>
> The more robust seasonal analysis presented here does not support an earlier PacifiCorp (2004; 2005d) broad postulation that the reservoirs benefit water quality by processing organic matter and nutrients from upstream sources. With the given data set, there is a clear indication that the reservoirs periodically increase nutrient loading downstream. Likely pathways for this increased load include internal sediment loading and nitrogen fixation by cyanobacteria."

Nutrient concentrations generally decline as the Klamath River flows downstream. There are three reasons for this:
1. Dilution by springs and clean tributaries
2. Periphyton growing on the bed of the river removes nutrients from the water column
3. Denitrification by micro-organisms in the hyporheic zone below the river converts nitrate into inert atmospheric nitrogen

1. Dilution
Nutrient concentration would decline as the river flows downstream from Keno to Iron Gate due to dilution with high-quality water from tributary and spring flow

inputs. These inputs include springs in the J.C. Boyle bypass reach (225 cfs) and tributaries between Link River dam and Iron Gate dam. The tributaries are Spencer Creek (approximately 20 to 200 cfs), Shovel Creek (10 to 100 cfs), Fall Creek (30 to 100 cfs) and Jenny Creek (30 to 500 cfs). Spencer, Shovel, and Jenny creeks all have irrigation diversions, so the actual quantity of water entering the Project may be less than stated here (PacifiCorp, 2004). The sum of these inputs ranges from 315 to 1125. Under current conditions, these beneficial inputs are negated due to KHP impoundments.

2. Assimilative Capacity of Periphyton
Benthic algae, also know as periphyton or attached algae, can take nutrients dissolved in water and assimilate them into their cells as they grow. This can enhance water quality by removing nutrients from the water, but it can also release nutrients when the algae decompose, causing diurnal D.O. and pH swings by photosynthesis/respiration cycles.

3. Denitrification in River Reaches
Denitrification is a process in which certain organisms can convert nitrate (NO_3) to atmospheric nitrogen (N_2). The result is enhanced water quality, due to the reduction in productivity that occurs because a form of nitrogen readily available to organisms (nitrate) is converted into a stable form of nitrogen that is essentially unusable by most organisms (atmospheric nitrogen). For denitrification to occur, adequate nitrate levels and low levels of dissolved oxygen must be present.

Figure 2 shows a typical example of the longitudinal gradient in nitrogen concentrations in the peak of the summer months. Only inorganic forms of nitrogen (nitrate and ammonia) are immediately available to fuel growth of periphyton and aquatic plants, organic nitrogen must first decay into ammonia before it can be utilized. Organic nitrogen is the most common form of nitrogen across the Klamath River. High levels of inorganic nitrogen are present throughout the upper reaches of the Klamath River. Beginning at the outlet of Iron Gate Dam (river mile 189.73), dense mats of periphyton and aquatic plants cover the river bed during summer. They are extremely efficient at removing nutrients, and within approximately 40 miles, above the Scott River at river mile 146.12, most inorganic nitrogen has been removed from the water column

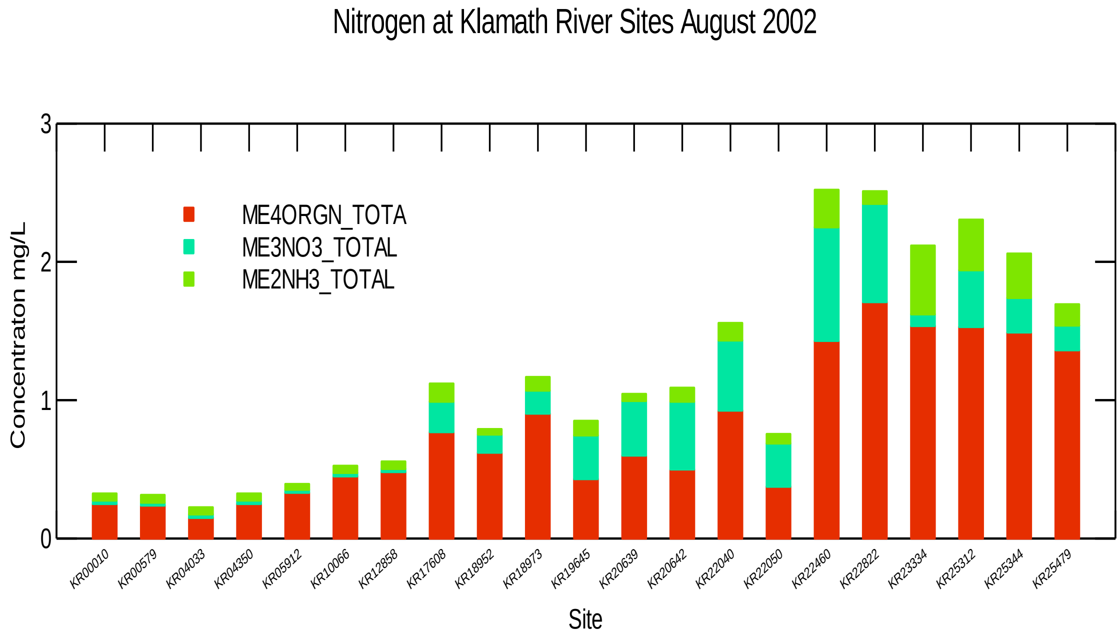

Figure 2. This graph shows the longitudinal gradient in average nitrogen concentrations in the Klamath River from Link River to the estuary in August 2002. The total height of the bars is total nitrogen concentration, and the colors represent the three major forms of nitrogen: organic (ME4ORGN_TOTA), nitrate (MENO3_TOTAL), and ammonia (MENH3_TOTAL). Figure is from Kier Associates (2005).

CYANOBACTERIA AND CYANOBACTERIAL TOXINS

PacifiCorp Proposed Mitigation

None

Yurok Tribe Recommendation

Recent studies have shown that the aging KHP reservoirs are causing the naturally occurring cyanobacteria *Microcystis aeruginosa* to propagate to unnatural levels, which in turn has serious environmental, nuisance and public health consequences both within the project and extending the entire length of the Klamath River below the project. The Yurok Tribe recommends that the only appropriate mitigation for this effect is to remove the KHP facilities.

Justification/Project Effects

Cyanobacteria, also known as blue-green algae, are a diverse group of single-celled aquatic organisms found in surface waters worldwide. Lakes, reservoirs, ponds, and slow-moving rivers are especially well suitable for cyanobacteria, and given the right conditions – calm water, light, the right concentration and ratio of N:P, these organisms can reproduce at a high rate, forming vast blooms in the water. The resulting high cyanobacterial algal concentrations are not only aesthetically unpleasing, but often produce toxins that have been implicated in human health problems ranging from skin irritation and gastrointestinal upset, to death from liver or respiratory failure (Chorus and Bartram 1999, Chorus 2001). *Microcystis aeruginosa* produces the potent hepatotoxin microcystin and has been demonstrated to occur in the Klamath River system (Kann 2006).

These hepatotoxins (liver toxins) are powerful cyclical peptides which disrupt the structure of liver cells, causing cell destruction, liver hemorrhage, liver necrosis, and death (Carmichael 1994). In addition to hepatotoxicity, long-term laboratory animal studies indicate that microcystins act as liver tumor promoters and teratogens (Falconer et al. 1988). Microcystin poisoning has been implicated in the largest number of cyanobacteria-associated animal deaths worldwide, and enough work has been done, both with rodents and pigs, on microcystin effects at various levels of exposure, that the World Health Organization (WHO) has issued a provisional guideline of 1 μg/L for microcystin concentration in drinking water. With actual microcystin concentration data frequently unavailable, alert level guidelines based on cell counts have been established for *Microcystis* (as well as other cyanobacteria) blooms in drinking and recreational waters (Yoo et al. 1995, Chorus and Bartram 1999).

Although human health effects of toxins from the blue-green algae *Microcystis aeruginosa* are better studied (WHO, 1998), fish health effects have also been recently researched (Zambrano and Canelo 1995, Wiegland and Pflugmacher 2005), including effects on salmonids (Tencalla et al. 1994, Bury et al. 1996; Fischer et al. 2000, Best et al. 2003). These effects are discussed here because there is evidence that hepatotoxins created by *Microcystis* are a threat to fish health independently, and may also act synergistically with other water quality problems (i.e. pH) in causing cumulative stress or in contributing to immunosuppression and subsequent outbreaks of fish disease epidemics.

Microcystin toxins accumulate in the liver where they disrupt many different liver enzymes and ultimately cause the liver to break down (Fischer et al., 2000). Algae grazing fish species may be the most susceptible to microcystin poisoning, but other fish may ingest whole *Microcystis* cells or breakdown products from the water column (Wiegland and Pflugmacher 2005). In laboratory experiments, rainbow trout were found to excrete microcystin toxins in bile fluids when exposed to them orally. The toxins caused increased drinking in this species and increased water in the gut, which was a sign of osmoregulatory imbalance and could promote diffusion of toxins into the blood (Best et al., 2003).

Tencalla et al. (1994) noted that large scale fish kills around the world have resulted from microcystin poisoning. They postulated that a 60 g rainbow trout would only have to ingest 0.1-0.4 g of algae (wet weight) or 0.2-0.6% of its body weight to experience massive liver damage. Bury et al. (1996) studied brown trout exposed to sublethal levels of microcystin toxins and found greatly altered blood cortisol levels indicating acute stress and reduced immunosuppression. This is a concern in the mainstem Klamath River because of the recognized fish health problems (Foott and Stone, 2003; Nichols and Foott, 2005), and the potential for additional diminishment of resistance to disease caused by microcystin exposure of juvenile salmonids.

Kann (2006) provides a summary of four datasets that provide information about the distribution and abundance of *Microcystis aeruginosa* (MSAE) in the Klamath River basin. These include data from the Klamath Tribes in 1990-1997, PacifiCorp in 2002-2004, Karuk Tribe/State Water Resource Control Board (SRWCB) in 2005, and Yurok Tribe/U.S. Fish and Wildlife Service (USFWS) in 2005.

The Klamath Tribes' 1990-1997 data showed that while MSAE is found in Upper Klamath Lake and Agency Lake, it was only rarely detected in the outlet to Upper Klamath Lake. PacifiCorp's data showed that MSAE was only detected twice (August 21, 2003 and September 10, 2002) in the Klamath River above Copco (river mile 206.42), but then was common in Iron Gate and Copco Reservoirs. In Karuk Tribe/SWRCB data from 2005, MSAE and microcystin toxin were never detected at the station above Copco Reservoir, but were common in Iron Gate and Copco Reservoirs and in the Klamath River at the outlet of Iron Gate Dam. Yurok/USFWS data from 2005 showed that MSAE and microcystin toxin were found in the Klamath River all the way from Iron Gate Dam to the Klamath estuary. Based on those results, Kann (2005) concludes:

> Taken together these data provide compelling evidence that Copco and Iron Gate Reservoirs are providing ideal habitat for MSAE; increasing concentrations dramatically from those upstream, and exporting MSAE to the downstream environment.

The results described above from multiple datasets and summarized by Kann (2005) indicate that Iron Gate and Copco Reservoirs were almost certainly responsible for the high levels of MSAE and microcystin toxin detected in the Klamath River between Iron Gate Dam and the estuary. No tributaries downstream of Iron Gate Dam showed a presence of MSAE.

Kann (2005) described the potential for Iron Gate and Copco Reservoirs to contribute to downstream blooms of MSAE:

> In areas where turbulent diffusivity may decrease as rivers widen and increase in depth, or such as would occur in backwater areas, the potential also exists for MSAE blooms in slow-moving riverine environments as well …Given the tens of thousands of MSAE cells introduced to the lower-Klamath River from Copco and Iron Gate

> Reservoirs above, the potential for recurring blooms downstream increases as slower-moving water is encountered. For example, as described above, MSAE cell concentration exceeded 1.3 million cells/ml in a backwater area near the confluence of Coon Creek nearly 100 miles downstream from Iron Gate Dam.

With dam removal, although *Microcystis* might persist at low levels in the Klamath River's quiet backwaters or perhaps in the Klamath estuary, its abundance would likely be reduced many fold. The reason is that its inoculant source (Iron Gate and Copco Reservoir) would be reduced by orders of magnitude, so that even in a suitable MSAE habitat such as a quiet backwater, blooms would take longer to develop because they would start from fewer cells, and cells would have less of a chance of dispersing to suitable habitats.

California's water quality standard for toxic substances states that "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life." (NCRWQCB, 2001).

To the extent that creation of the KHP reservoirs resulted in formation of habitat conditions ideal for *Microcystis*, with subsequent increased microcystin concentration in the waters of the Klamath River, operation of the KHP appears to be violating California's toxic substances water quality standard.

It should also be noted that, although PacifiCorp collected algae data for 3 years, the company was resistant to release it to the public and did not include any results in its FLA or subsequent filings with the FERC.

DISSOLVED OXYGEN

PacifiCorp Proposed Mitigation

None

To mitigate KHP impacts to dissolved oxygen, PacifiCorp (2005b) has studied an oxygen diffuser system for Iron Gate reservoir. PacifiCorp has stated that the diffuser would be effective in increasing dissolved oxygen levels in Iron Gate Dam releases but is not recommending it as a mitigation measure.

Yurok Tribe Recommendations

Dam removal would eliminate the KHP's effects on dissolved oxygen levels in the Klamath River by restoring the physical, chemical and biological processes that regulate dissolved oxygen in free flowing rivers.

Justification/Project Effects

The KHP has both direct and indirect effects on dissolved oxygen in the Klamath River.

The KHP has a direct effect on dissolved oxygen (D.O.) levels in the Klamath River immediately below Iron Gate Dam because during the summer season, the reservoir often releases water with low levels of oxygen. Due to oxygen exchange between the water surface and the air, dissolved oxygen levels should rise once the water is flowing down the river; however, in the Klamath River there is excessive growth of aquatic macrophytes and periphytic algae which causes large diurnal fluctuations in dissolved oxygen levels.

To the extent that the project increases nutrient levels, it stimulates growth of aquatic macrophytes and periphyton that drive large diurnal swings in D.O., including low D.O. at night.

Other Water Quality Factors

PacifiCorp Proposed Mitigation

None

Although there is evidence that the KHP also has deleterious effects in relation to periphyton levels, pH, ammonia toxicity, and taste and odor compounds, PacifiCorp has not put forth any proposed mitigation measures.

Yurok Tribe Recommendations

Consistent with the recommendations made above, and in conjunction with the following *Justification/Project Effects* section below, the Yurok Tribe has found that in every case the project effects are immitigable, thus KHP decommissioning is the only viable mitigation measure that could adequately remedy current and future impacts to Klamath River water quality and associated beneficial uses.

Justification/Project Effects

PERIPHYTON AND AQUATIC MACROPHYTES

Background information

EPA (2000) presents an excellent review of literature on how periphyton grow in response to nutrient availability, and how they in turn affect dissolved oxygen and pH. Based on that review, EPA (2000) provides a general guideline that the level at which periphyton typically starts to become a nuisance to water quality and aesthetics is 150 mg/m^2. Additionally, Horner et al. (1983) conducted a literature review of 19 case studies and concluded that biomass levels greater than 150 mg/m^2 often occurred with enrichment and when filamentous forms were more prevalent. Welch et al. (1988) noted that percent coverage by filamentous forms was less than 20 percent at 150 mg/m^2, but increased as biomass increased, noticeably affecting aesthetic quality (Welch et al. 1988).

Existing conditions in the Klamath River

In 2004 there was a collaborative study of Klamath River periphyton by the North Coast Regional Water Quality Control Board, the Yurok Tribe, and PacifiCorp. They collected periphyton samples in the Klamath River at sites between Iron Gate Dam and Weitchpec, including tributary streams. Although this dataset spans only one algal growing season, and hence is relatively limited in that respect, it is the best data currently in existence. All parties used similar sampling methodologies (Eilers 2005, NCRWQCB et al. 2005) and the same laboratory. Additional information on this study's results is contained in Kier Associates (2005).

The 2004 periphyton data samples show interesting spatial and temporal patterns, and indicate that maximum annual periphyton levels at many sites on the Klamath River far exceed the EPA's general guidance of 150 mg/m^2 (Figure 3). In early July 2004 all sites sampled had chlorophyll *a* values of 82 mg/m^2 or less, except for the Klamath River above the Scott River (river mile 142.61), which was 353 mg/m^2. For the August samples, periphyton biomass increased at most sites, exceeding 150 mg/m^2 at 5 of 9 sites sampled with the highest biomass of 706 mg/m^2 at river mile 183.28 (Klamath River above Cottonwood Creek). In late August, the flow released from Iron Gate Dam increased from 615 cfs to a peak of 1320 cfs, before declining to 913 cfs. The flow increase likely caused significant scour of periphyton because biomass decreased from 706 mg/m^2 at river mile 183.28 in August to 9 mg/m^2 at river mile 179.23 on September 1, and biomass also declined substantially at river mile 142.61. Biomass held stable at river mile 98.5, and increased in the lower river at river miles 70.30 and 43.50. Biomass may not have declined in the lower river because the Klamath River's channel generally widens as it flows downstream, and so the flow likely had less scouring affect and algae continued to grow. It is difficult to generalize from one year of data, and it is unknown if similar patterns occur in other years.

The most common species identified in 2004 samples were *Cymbella affinis* (CMAF), *Cocconeis placentula* (COPC), *Diatoma vulgare* (DTVL), *Epithemia sorex* (EPSX), *Navicula cryptocephala veneta* (NVCV), and *Nitzschia frustulum* (NZFR). All six of these species are classified by the US Geological Survey as eutrophic and alkalophilic (NCRWQCB et al. 2005).

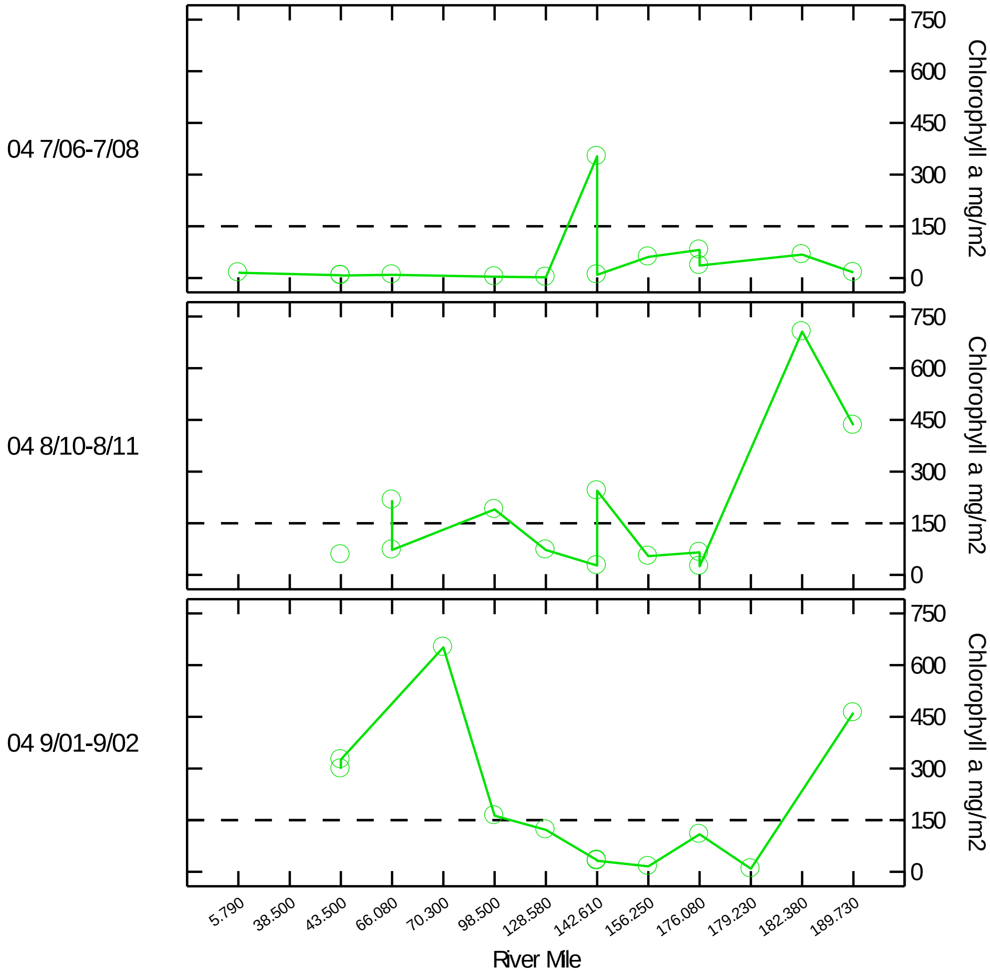

Figure 3. Periphyton biomass as mg/m² chlorophyll *a* in the mainstem Klamath River for the year 2004, grouped by sampling period and sorted by river mile. Sampling periods begin with year, followed by month-day range (i.e. 04 9/01-9/02 is 9/01/2004-9/02/2004). EPA (2000) general guidance of 150 mg/m² is shown as a horizontal line on the charts.

Little or no data have been collected on aquatic macrophytes in the Klamath River. Below the Scott River macrophytes are present only in quiet backwater areas (PacifiCorp, 2005d). They are known to be common in the Klamath River between the Iron Gate Dam and the Scott River, likely due to the stable nature of the channel in that reach (PacifiCorp, 2005d). In that reach, they may play an important role in dissolved oxygen and pH dynamics.

Project effects

Biggs (2000) provides a comprehensive guide to periphyton ecology and management. The review includes a summary of the three main ways in which dams affect periphyton in rivers:

> “First, the placing of a dam or some form of barrage across the river alters (or completely stops) the flow of bed sediments moving down the river. This then usually enhances bed armoring (i.e., paved with very stable, large cobbles and boulders on the surface layers) which provides excellent substrata for periphyton to attain a high biomass. Second, most of the small- and medium-sized floods are prevented from flowing down the river (unless the reservoir is at storage capacity), which means that the normal flow variability is reduced and the natural ability of the system to remove excess accumulations of biomass is also reduced. Third, the reduction in flow usually also results in a reduction in water velocities, which then allows a higher biomass of filamentous green algae to develop if nutrient levels are sufficient.”

Biggs’ (2000) first and second points are likely occurring in the Klamath River as a result of the KHP. In addition, the third point is likely occurring in the Klamath River as well, but more likely as a result of upstream agriculture rather than the KHP.

Geomorphic changes
As noted in the citation from Biggs (2000) above, dam construction typically halts the downstream transport of gravel, resulting in more course substrates. The KHP has had this effect on the Klamath River below Iron Gate Dam. Larger substrates like cobble and boulder require higher flows to scour them than smaller substrates like gravel and sand. This provides a more stable substrate, increasing the amount of periphyton and aquatic macrophytes than can grow.

The effect of the KHP on bed substrate likely diminishes with increasing distance downstream of Iron Gate as each successive tributary introduces gravels to replenish a portion of the deficit.

Hydrologic changes
Though not designed for flood-control, Iron Gate and Copco Reservoirs do influence the hydrologic regime by reducing peak streamflows during moderate and small storm events. Peak flows from tributaries such as Jenny, Spencer, and Shovel Creeks can be captured by the reservoirs. Hydroelectricity can only be generated when water flows through the turbines, not the spillways, so it is in PacifiCorp’s best interests to minimize use of the spillways. Hence, PacifiCorp may draw down its reservoirs in anticipation of storms to capture storm flows. This helps provide a stable flow regime that allows periphyton and macrophytes to flourish. Periphyton and macrophytes are sensitive to scouring in high flows so a reduction in frequency and intensity of peak flows may cause an increase in periphyton and macrophyte growth. Photosynthesis and respiration of periphyton and macrophytes is a major driver of pH and dissolved oxygen dynamics in the Klamath River so allowing an increase in periphyton and macrophytes may further degrade water quality.

While these hydrologic effects likely contribute to periphyton macrophyte growth between Iron Gate Dam and the Scott River, effects are likely insignificant below the Scott because winter storms are unregulated in the Scott and it contributes large amounts of water during storm events.

Nutrients
Many factors govern the biomass of periphyton that occurs in a stream at any given time. The explanations here are abbreviated; for full details see Biggs (2000). The most important include the amount of available nutrients, light, temperature, and number of days since scour (Biggs 2000). When nutrients and light are adequate to fully meet the demands of the periphyton community, then temperature governs the rate of accrual. The upper limit of biomass accrual is then determined by nutrient concentration and grazing intensity.

Present-day (with KHP) nutrient concentrations in the Klamath River below Iron Gate Dam are likely higher than they would be without the KHP. The reasons for this are discussed above and include nitrogen fixation in KHP reservoirs, reduction in assimilative capacity through peaking operations; bypass operations, and inundation of free-flowing river reaches by reservoirs. This increase in nutrients likely leads to an increase in the amount of periphyton and aquatic macrophytes, which degrades pH and dissolved oxygen conditions, harming fisheries.

Remediation
The coarsening of the streambed below Iron Gate Dam could potentially be remedied by gravel augmentation, though the quantity of gravel required to fully compensate for KHP effects would likely be prohibitively expensive, and could cause damage to the stream where the gravel was removed from.

Pulse flows from Iron Gate Dam could potentially be used to prevent excessive growths of periphyton and aquatic macrophytes; however, this might have unintended consequences as the system is not fully understood. For example, artificially limiting periphyton growth near Iron Gate Dam might the move the zone of poor water quality downstream, merely relocating the problem rather than solving it.

Dam removal would allow gravel to move downstream at its natural rate, restore natural hydrology, and remedy the KHP's impacts to nutrient dynamics.

pH

Background information
Evidence from laboratory studies indicates that any pH over 8.5 is stressful to salmonids and 9.6 is lethal (Wilkie and Wood 1995). Studies show that as water reaches a pH of 9.5, salmonids are acutely stressed and use substantial energy

to maintain pH balance in their bloodstream (Wilkie and Wood 1995), while pH in the range of 6.0 to 8.0 is normative.

Wilkie and Wood (1995) note that when the gill membranes of bony fishes, including salmonids “are exposed to alkaline water there is an immediate reduction in ammonia excretion rate and a corresponding increase in plasma ammonia concentration.” The direct stress effects of increased pH in the Klamath River are compounded by increasing unionized ammonia, which is triggered by increasing pH in conjunction with typically warm water conditions in summer (see below).

Prolonged exposure to pH levels of 8.5 or greater may exhaust ion exchange capacity at gill membranes and lead to increased alkalinity in the bloodstream of salmonids (Wilkie and Wood 1995). This internal shift in chemistry facilitates conversion of internal ammonium to dissolved ammonia (Heisler 1990). In case of extreme pH swings “NH_3 and NH_4^+ concentrations rise too rapidly and/or approach toxic levels, internal ammonia can ultimately contribute to high pH induced mortality” (Wilkie and Wood 1995). Dissolved ammonia causes a similar diffusion pressure on the gills to high pH as salmonids try to convert NH_3 into more benign NH_4^+, thus causing loss of H^+ ions at the gill membrane. This compounds problems in maintaining pH balance in the bloodstream of juvenile and adult salmonids exposed to both stressors.

Existing conditions in the Klamath River

The NCRWQCB (2001) Basin Plan standard for the Klamath River is that pH should not exceed 8.5, but this standard is exceeded on a daily basis across large portions of the river (Figures 4 and 5). Figure 4 shows the average maximum pH during the month of August at all locations monitored on the Klamath River from 2000-2004. The pH rises above levels known to be stressful to salmonids at locations immediately below Iron Gate Dam (RM 189.13) downstream to the mouth of the Shasta River (RM 176.08). The data show considerable variability between sites and between years. The variability of pH between years is reflective of changes in flows, climatological conditions, and other factors, but the consistent exceedance of the NCRWQCB pH standard of 8.5 is an indication of pervasive nutrient pollution and consequently a high probability of problems for fish health.

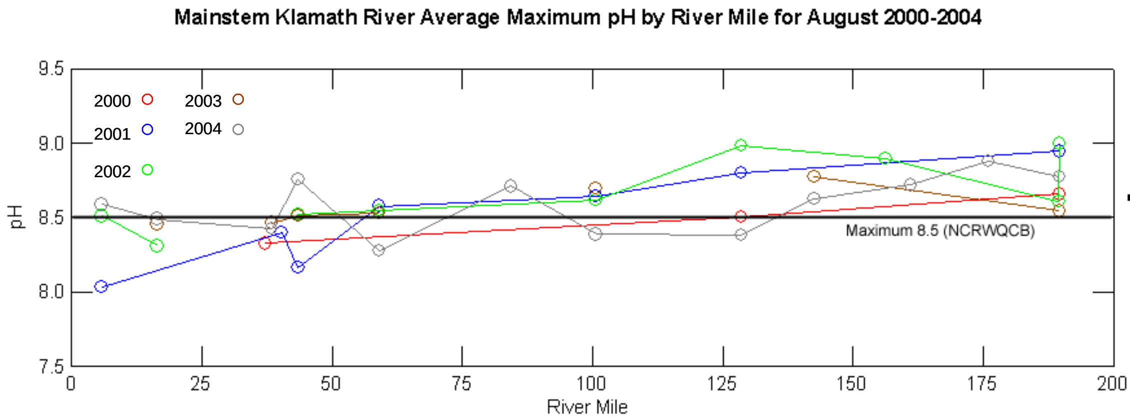

Figure 4. Average maximum pH of the Klamath River by river mile showing patterns for the years 2000-2004. The horizontal line shown on the graph is the NCRWQCB (2001) standard for pH. Data are from the USFWS, Karuk Tribe, Yurok Tribe and USGS. Figure is from Kier Associates (2005).

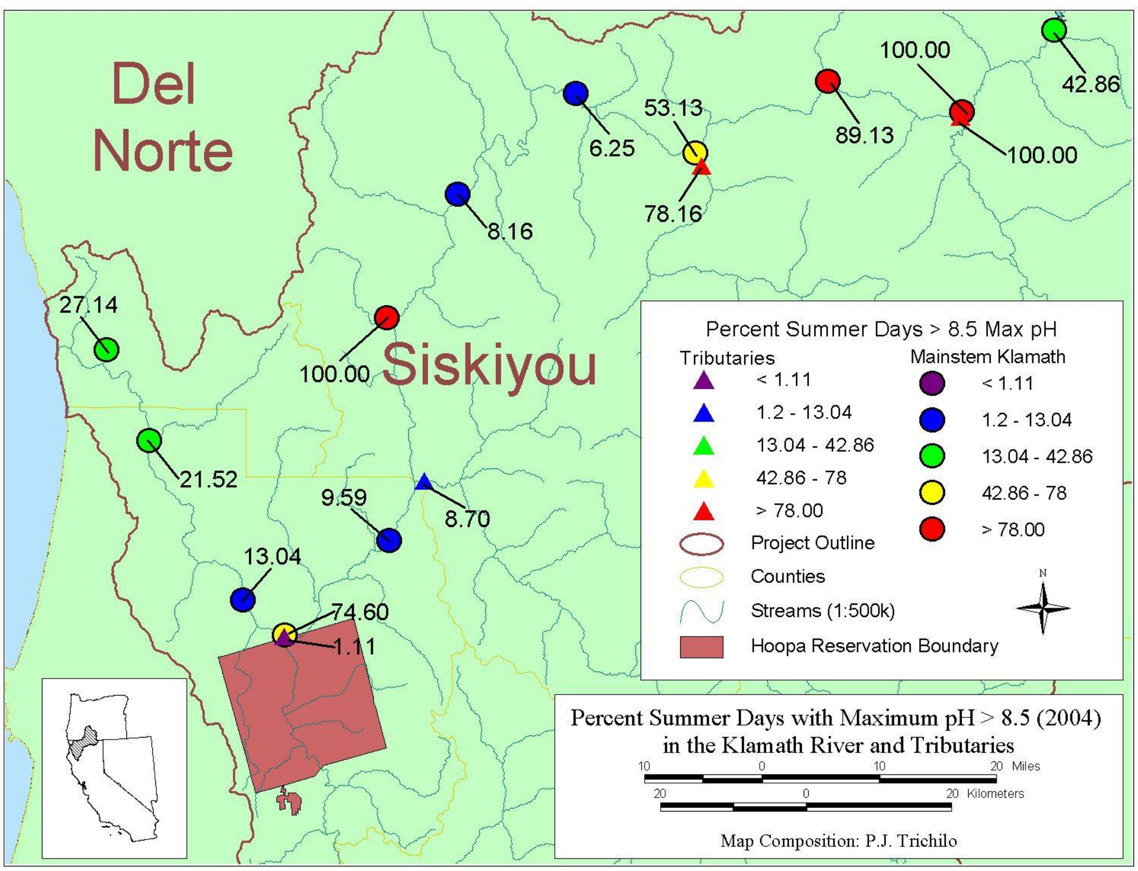

Figure 5. Map showing the percent of summer days in 2004 where maximum pH exceeded 8.5. Data are from Yurok Tribe, Karuk Tribe, and U.S. Fish and Wildlife Service. Figure is from Kier Associates (2005).

Project effects

The KHP has both direct and indirect effects on pH in the Klamath River.

The KHP has a direct effect on pH levels in the Klamath River immediately below Iron Gate Dam, as during the summer season the reservoir often releases water with high pH (Figure 4). This effect is likely localized in impact, though it is unknown how large the area is.

Levels of pH are elevated throughout the Klamath River below Iron Gate Dam (Figures 4 and 5), and it is likely that the pH of water released from Iron Gate Dam does not drive this except for the reach immediately below the dam. Further downstream of the dam, high pH is caused by excessive photosynthesis of aquatic macrophytes and periphytic algae.

To the extent that the project increases nutrient levels, or delays decreases in nutrient levels, it stimulates growth of aquatic macrophytes and periphyton that drive large diurnal swings in pH, including high pH during the daylight hours.

If the phytoplankton that are flushed out of Iron Gate Reservoir into the Klamath River below continue to photosynthesize, then they contribute to diurnal fluctuations of dissolved oxygen.

The Periphyton and Aquatic Macrophytes section above provides additional information on how the KHP encourages growth of periphyton and aquatic macrophytes, and hence increases pH.

Remediation

Dam removal would eliminate both the KHP's direct and indirect effects on pH. PacifiCorp has not proposed a way to mitigate pH impacts.

AMMONIA TOXICITY

Background information

Ammonia is a nitrogen-containing compound this is toxic to fish, but is also a nutrient for aquatic plants and algae. Ammonia's toxicity to fish depends on ammonia concentration, temperature, pH, and duration of exposure (U.S. EPA 1999). As pH and temperature increase, ammonia converts from ammonium ions to unionized or dissolved ammonia that is lethal to salmonids at very low levels. Goldman and Horne (1983) explained that conversion of ammonium to dissolved ammonia is prompted by increasing pH with greater than 38% converted at a pH of 9.0 and a water temperature of 25 ^{O} C.

Existing conditions in the Klamath River

Most nutrient data that have been collected on the Klamath River have been processed by laboratories that did not have adequately low reporting limits. Consequently, a sample could be reported as a non-detect, but ammonia levels could be high enough to be acutely toxic to fish, or even lethal. We did not perform the specific calculations required to query available data to determine if the ammonia criteria are being exceeded, as the upcoming Mainstem Klamath TMDL will include ammonia toxicity analysis (St. John. pers. comm.).

One of the few datasets with adequate reporting limits for ammonia was the North Coast Regional Water Quality Control Board 104b water quality data from 1996 and 1997. These data show that maximum dissolved ammonia can reach levels well above those recognized as acutely stressful to salmonids (Heisler 1990). Maximum levels of dissolved ammonia for 1996 and 1997 by Klamath River location indicate that problems with this substance may be more pronounced in reaches further downstream from Iron Gate Dam (Figure 6).

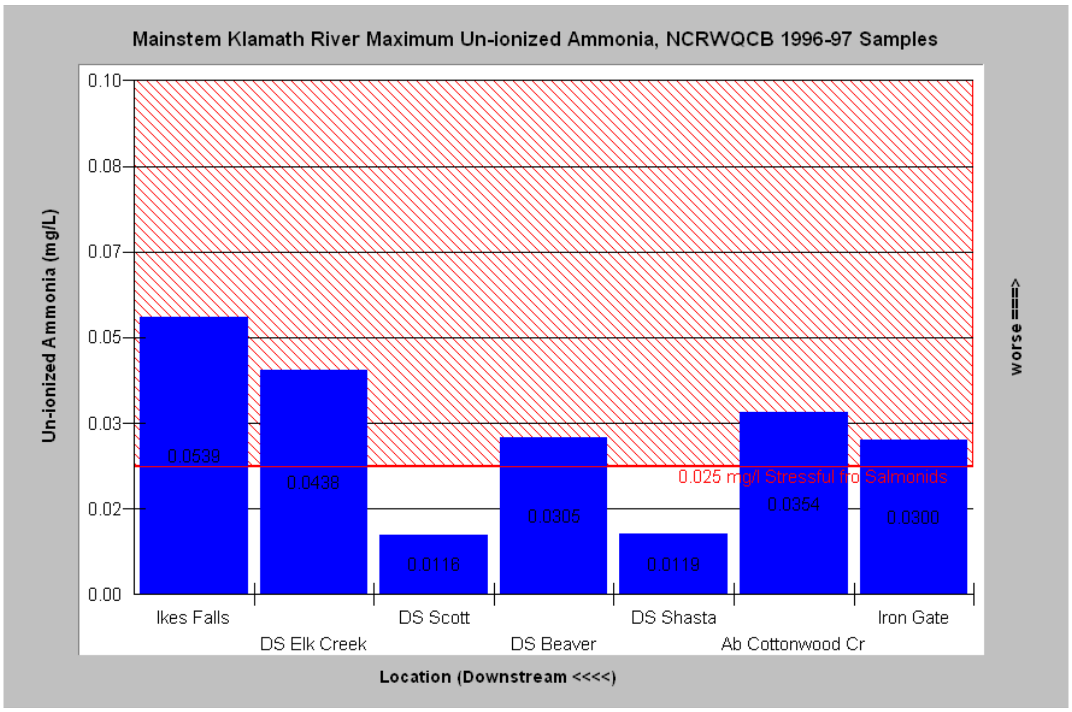

Figure 6. The maximum dissolved ammonia (also known as unionized ammonia) levels measured in grab samples collected in 1996 and 1997 show levels in the highly stressful to lethal range for salmonids as far downstream as Ike's Falls near Orleans (RM 65.93). Data were collected by the North Coast Regional Water Quality Control Board as part of the 104b program.

Project effects

Data from the year 2002 (Kann and Asarian 2005) show that Iron Gate and Copco Reservoirs exhibited substantial negative net retention of ammonia, indicating that both are major sources of ammonia (Figure 7). For the overall April-November 2002 period, net retention in Copco was -44% and Iron Gate was -32%. While the magnitude and timing of ammonia releases likely varies from year to year, it is highly likely that it occurs in all years.

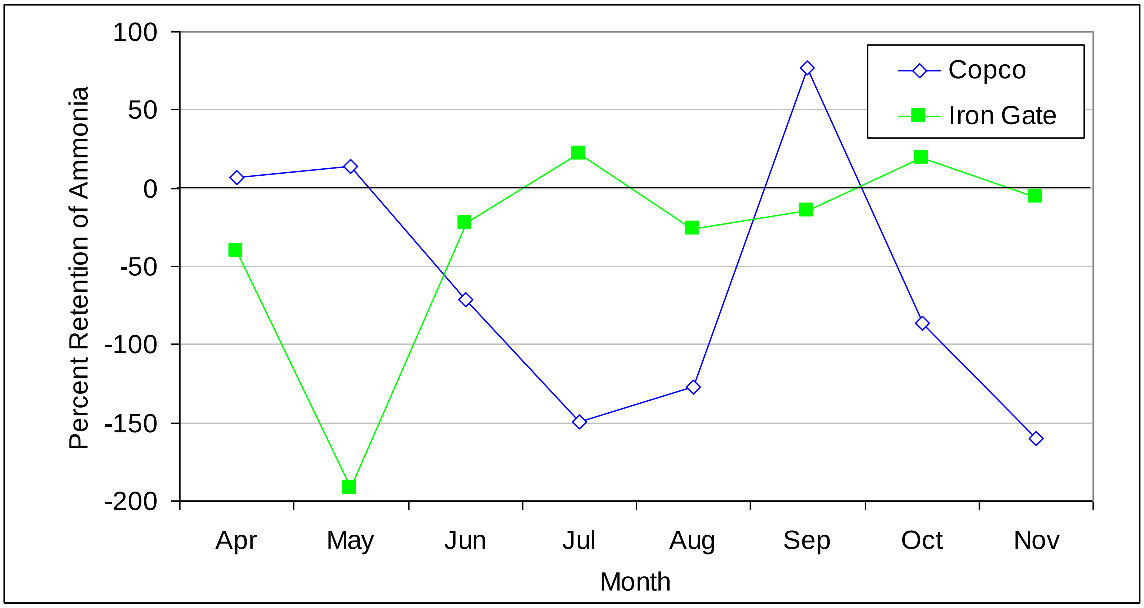

Figure 7. Percent retention of ammonia by month at Iron Gate and Copco Reservoirs in 2002, by month. Negative retention signifies source, positive retention signifies sink. Retention calculated as incoming load minus outgoing load, minus change in storage. Retention percentage is calculated as retention divided by incoming load. Chart made from summarizing calculations provided in the appendices of Kann and Asarian (2005). Data originally collected by PacifiCorp and U.S. Fish and Wildlife Service.

Although Iron Gate Dam releases substantial ammonia into the Klamath River, much of that ammonia is likely transformed relatively rapidly into nitrate or is uptaken by periphyton and aquatic macrophytes.

Ammonia releases from Iron Gate Dam represent a substantial localized risk to fish in the vicinity. In addition, ammonia releases from Iron Gate also represent a risk to downstream reaches because if assimilative capacity of periphyton and macrophytes are temporarily diminished (i.e. due to cloudy weather, cold temperatures, or turbidity) then ammonia could move downstream intact. This may occur at least occasionally, because high levels of unionized ammonia has been detected far downstream of Iron Gate (Figure 7). Due to its potential for extreme toxicity, ammonia presents a significant risk to fish health. It should be noted here that ammonia downstream could also be caused by a phenomenon known as nutrient spiraling, where nutrients are absorbed and then are released (such as when periphyton is scoured or senesces), cascade downstream, break down, and then become available again for growth.

TASTE AND ODOR COMPOUNDS

Background information

The issue of taste and odor compounds may seem at first like a minor issue, but in the Klamath Basin it is an important one. Fish growing in water containing taste and odor compounds can take these compounds into their tissues.

Recreational fishing can be adversely affected by off-flavored fish because eating such fish becomes less desirable. This, in turn, can have negative economic effects on recreational economies, including bait and tackle sales and boat and cottage rentals (EPA 1986). Several Native American Tribes in the Klamath basin have subsistence fisheries, which is another reason why taste and odor compounds are important issues. Furthermore, the Yurok Tribe conducts commercial fisheries when the abundance of stocks is large enough.

Taste and odor compounds come from a diverse group of sources, including municipal wastewater treatment discharges, refinery wastes, and wastes from slaughterhouses (EPA 1996). A likely source of potential taste and odor compounds in the Klamath River is algae. As it grows and decays, algae can produce undesirable tastes and odors in water (EPA 1996 and Droste 1997). Smith and deNoyelles (2001) provide a summary of the background and history of taste-and-odor compounds in surface water, as does Mau et al. (2004).

Many algal species are capable of producing tastes and odors, including various Bacillariophyta, Chlorophyta, Cryptophyta, and *Actinomycetes*. Taste and odors vary between species. Species causing "grassy" or "musty" odors include the diatoms *Melosira* and *Synedra*, as well as the Cyanobacteria *Anabaena* (Palmer 1977). Diatoms that can cause "fishy" odors include *Asterionella*, *Cyclotella*, and *Chlamydomonas* (Palmer 1977). Cyanobacteria *Oscillatoria spp*. and *Lyngbya limnetica* are capable of producing “musty odor” (Palmer 1997). Other species know to produce taste and odor compounds include the Cyanobacteria *Aphanizomenon*. *Actinomycetes* are moldlike bacteria than can break down organic matter and produce many taste and odor compounds including geosmin, an earthy-smelling byproduct which is also produced by Cyanobacteria (Droste 1997).

Some of the most severe taste and odor problems have been associated with blooms of cyanobacteria (Mau et al. 2004). Two chemical compounds found within certain species of cyanobacteria, geosmin and 2-methylisoborneol (MIB), are responsible for many of the taste and odor problems associated with cyanobacteria blooms (Gerber, 1969; Tabachek and Yurkowski, 1976).

Existing conditions in the Klamath River

While we are not aware of any quantitative data regarding the types and concentrations of taste and odor compounds in the Klamath River, it is widely recognized that salmon caught on the middle Klamath River (between Iron Gate Dam and the Trinity River) have poor odor and taste. This was eloquently stated by staff of the Quartz Valley Indian Reservation during a meeting with FERC (2004):

> “Around here, when people say that they got salmon, the first question that you ask is where did you get it from? If they got it up

> river, you don't want to eat it. People that don't know, eat it. But people that know get it farther down."

PacifiCorp conducted a survey of recreational users in the KHP area and results are included in Water Resources Final Technical Report Appendix 13a Klamath Water Quality/Aesthetics Survey Responses (PacifiCorp 2004). Thirty-six percent of recreational users indicated that water quality affected their visit to the Klamath River and many respondents commented on the excessive algae, green water, foam, suds, and bad odors found in the KHP reservoirs and river reaches. Comments included the following:
- "Bad smell this year" (regarding Keno and Lake Ewauna)
- "Slimy, green, foamy – yuck" (regarding Copco/Lower Klamath)
- "Extremely filthy (also dead fish everywhere)" (regarding J.C. Boyle)

Humboldt State University graduate students are conducting studies of the relationships between nutrients, *Actinomycetes*, and geosmin in the mainstem Klamath River but have not published their results yet (Gearheart, pers. comm.).

Project effects:
Data on taste and odor compounds is lacking in the Klamath River, but analysis of phytoplankton and nutrient data, combined with information about taste and odor compounds from literature derived in other locations, suggests that the KHP is likely increasing taste and odor compounds in the Klamath River.

Each year, KHP reservoirs such as Iron Gate and Copco host massive algae blooms. Organic matter (likely live and dead algae) can be flushed downstream in the Klamath River below (Kann and Asarian 2005). These blooms are likely contributing to taste and odor problems both directly through metabolic byproducts of the algae, as well and indirectly through increasing organic matter which can later be decomposed by *Actinomycetes* to produce geosmin and other taste and odor compounds. In addition, anaerobic conditions in the bottoms of the reservoirs may also produce taste and odor compounds.

Remediation
As described above in the nutrients section, copper-based algaecides could potentially be used to reduce algal growth and hence reduce taste and odor compounds, but we strongly discourage this approach due to potential for unintended downstream consequences.

Removing KHP dams and reservoirs would reduce algal production and anaerobic conditions, likely reducing taste and odor compound production. As discussed in the nutrients section above, it would also likely reduce levels of nutrients and organic matter in the Klamath River downstream, which should reduce algal growth as well as reduce the amount of geosmin produced by *Actinomycetes* (which feed on organic matter).

Taste and odor-causing compounds are often volatile and can be removed to a significant extent by aeration (Droste 1997). Adding oxygen to water can improve the taste of water to a limited extent (Droste 1997). Dam removal would replace anaerobic reservoirs with many miles of a free-flowing river that has a much higher surface area to volume ratio than the reservoirs, which would allow for more replenishment of oxygen. In addition, free-flowing rivers feature naturally-occurring gravity-powered aeration features known as riffles, which further serve to oxygenate the water. The increase in surface area to volume ratio and increase in the number of riffles would likely result in more aeration and hence more removal of taste and odor compounds from the waters of the Klamath River.

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