Klamath River Expert Panel

FINAL REPORT

Scientific Assessment of Two Dam Removal Alternatives on Coho Salmon and Steelhead

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THE FINDINGS AND CONCLUSIONS IN THIS REPORT ARE THOSE OF THE AUTHORS AND DO NOT NECESSARILY REPRESENT THE VIEWS OF THE FUNDING AGENCY (U.S. FISH AND WILDLIFE SERVICE).

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Executive Summary

The Secretary of the Department of the Interior is required to decide if implementation of the Klamath Hydropower Settlement Agreement (KHSA) and Klamath Basin Restoration Agreement (KBRA) (1) will advance restoration of the salmonid fisheries of the Klamath Basin; and 2) is in the public interest. Two alternative management scenarios before the Secretary of the Interior must be addressed in the Secretarial Determination: (1) Conditions with dams, also referred to herein as the "Current Conditions"; and, (2) Conditions without dams and with the KBRA, also referred to herein as the "Proposed Action." This expert panel (Panel) was convened to attempt to answer a provided list of specific questions that had been formulated to distinguish between the effects of the two alternatives (Current Conditions and the Proposed Action) on coho salmon (*Oncorhynchus kisutch*) and steelhead (*Oncorhynchus mykiss*). Coho salmon in the Klamath River Basin are included in the Southern Oregon/Northern California Coast Evolutionary Significant Unit (SONCC ESU) and were federally listed as threatened under the Endangered Species Act on May 6, 1997 (62 FR 24588). Critical habitat was designated for coho salmon on May 5, 1999 (64 FR 24049). Steelhead in the Klamath River Basin are included in Klamath Mountains Province Evolutionary Significant Unit (KMP ESU). While steelhead are not as yet listed as threatened or endangered, the National Marine Fisheries Service (NMFS) remains concerned about the status of KMP ESU steelhead (West Coast Steelhead Biological Review Team 2001). Steelhead in the Klamath River Basin consists of winter and summer runs.

The Panel faced a difficult challenge. The Panel was presented with an enormous amount of material, spread out in many documents. The proponents of the Proposed Action provided no single synthesis or overview document compiling their conclusions along with the supporting scientific evidence. The panel furthermore was funded to meet for only 5 days and the report at the end of that time. While a tight deadline does concentrate the mind, and encourages focus on the most important of the evident issues, it also exacts a cost in limiting the depth of the review. Most especially, it limits the opportunities to follow a trail of scientific evidence back to its source in original data, and to resolve conflicting sources of information. Thus, the Panel relied, to a considerable extent, on the summary information made available, other published information, and their expertise and experience with other systems. The Panel's statements are based on careful review of this material and group discussions. However, the Panel's statements are no substitute for further scientific investigation. The Panel recommends that its statements not be used in lieu of doing the necessary and feasible data collection, analyses, and modeling that is recommended below.

Missing from the information provided to the Panel are a detailed plan of implementation of the KBRA; an integrated view of how the two alternatives might affect specific life stages of each species; and stage-specific or life-cycle models. Such models would allow the contrasting effects of the two actions on reproduction, growth, mortality, and movement to be quantified and combined within and across life stages into a population response. To permit quantitative

estimation, KBRA actions should be specified in terms of location, timing, duration, extent, expected use by species and life stage, and resultant changes in reproduction, growth, and survival. This effort requires integration of information gathering and analysis, and it requires commitments to a predictable decision-making process to ensure effective allocation of resources within the restoration program. Given the lack of integration of decision rules for KBRA activities with information and analysis (models) about the likely responses of habitat and fish, the Panel can make only qualitative statements conditional on assumptions about the missing pieces of the puzzle.

With that backdrop, the Panel offers partial answers to the questions posed and the following overall conclusions, based on a synthesis of our responses to the questions.

(1) Although Current Conditions will likely continue to be detrimental to coho, the difference between the Proposed Action and Current Conditions is expected to be small, especially in the short term (0-10 years after dam removal). Larger (moderate) responses are possible under the Proposed Action if the KBRA is fully and effectively implemented and mortality caused by the pathogen *C. shasta* is reduced. The more likely small response will result from modest increases in habitat area usable by coho with dam removal, small changes in conditions in the mainstem, positive but unquantified changes in tributary habitats where most coho spawn and rear, and the potential risk for disease and low ocean survival to offset gains in production in the new habitat. Very low present population levels and low demographic replacement rates indicate that large improvements are needed to result in moderate responses. The high uncertainty in each of the many individual steps involved for improved survival of coho over their life cycle under the Proposed Action results in a low likelihood of moderate or larger responses (i.e., any single step can offset gains on the other steps). Improvements on the order of two to four times the current freshwater survival are likely needed to offset the current low marine survival. Nevertheless, colonization of the Project Reach between Keno and Iron Gate Dams by coho would likely lead to a small increase in abundance and spatial distribution of the ESU, which are key factors used by NMFS to assess viability of the ESU.

(2) The Panel is more optimistic that the Proposed Action could result in increased spatial distribution and numbers of steelhead, and in the long term (decades), increased numbers relative to those under Current Conditions. If the Proposed Action is implemented ineffectively, there may be no detectable response of steelhead. If the Proposed Action is implemented effectively, and the other related actions occur [e.g., Total Maximum Daily Load (TMDL)], then the response of steelhead may be broader spatial distribution and increased numbers of individuals within the Klamath system. This assessment is based on the likelihood of steelhead being given access to substantial new habitat, steelhead being more tolerant than coho to warmer water, the fact that

other similar species (resident redband/rainbow trout[1]) are doing well in the upstream habitat, and that steelhead are currently at lower abundances than historical values but not yet rare. Key issues affecting success will be how the KBRA is implemented, the degree of colonization of the upper watershed by steelhead, the success of passage through the unfavorable conditions in Keno Reservoir and upper Klamath Lake, how reliant the current population is on hatchery fish, the outcome of interactions between steelhead and resident *O. mykiss*, and the influence of hatchery releases on the fitness of wild fish.

(3) The questions posed to the Panel are not answerable in quantitative terms. The Panel was provided with qualitative information and asked to respond to questions requiring quantitative answers. The Panel identified six principal obstacles to drawing convincing conclusions between the two alternatives: (1) insufficient specificity of the KBRA; uncertainties about (2) fish passage through Keno Reservoir and Upper Klamath Lake, (3) hatchery effects, (4) disease, and (5) water demand responses to KBRA; and, (6) limited understanding about coho and steelhead abundances, migration patterns, and factors affecting survival at each life stage. With this degree of uncertainty, the Panel guardedly gave partial answers to the questions, still with some misgivings because of the potential for misinterpretation of the Panel's responses. "Expert opinion," even of an independent panel, should not be used as a substitute for scientific analysis of solid data.

(4) As part of this report, the Panel offers general recommendations, beyond responding to the questions in the charge. These general recommendations give the Panel's advice on how to ensure that the best scientific information is brought to bear on this important issue in the future. These recommendations include: development of an overall conceptual model, ensuring access to needed expertise for quantitative analyses, formation of a centralized science advisory group with strong leadership, formulation of monitoring and research plans, specification of the details of the actions within the KBRA and how they will be implemented, some additional temperature analyses and modeling to better characterize within-day variability, and development and use of stage-specific and life cycle models of growth, mortality, reproduction, and movement to better contrast the Current Conditions versus the Proposed Action alternatives, and if the dams are removed, to ensure the effectiveness of the KBRA.

[1]Redband trout, rainbow trout, and steelhead are all part of a complex aggregation of sub-species and life histories of *Oncorhynchus mykiss*. For ease of the reader, the term *O.mykiss* is used to refer to the resident form of redband/rainbow trout and the term steelhead is used for the anadromous life history pattern.

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1.0 Introduction

The allocation of water among competing uses in the Klamath Basin (Figure 1) has often been contentious. In recent years, stakeholders began discussions to reach a settlement agreement that would equitably resolve water resource management conflicts in the basin. In February 2010, this goal was reached when two settlement agreements were signed. Six dams occur along the Klamath River between Upper Klamath Lake and Interstate 5 (Figure 2). These dams include Iron Gate, Copco 2, Copco 1, J. C. Boyle, Keno Dam, and Link River Dam. The Klamath Hydroelectric Settlement Agreement (KHSA) would result in the removal of Iron Gate, Copco 2, Copco 1, and J. C. Boyle dams, as well as facilities of the Klamath Hydroelectric Project located on the Klamath River and operated by PacificCorp. The removal of the dams together with improvement of fish passage facilities at Keno Dam and Link Dam would provide for upstream anadromous fish passage to historically occupied habitats. The Klamath Basin Restoration Agreement (KBRA) addresses basin-wide environmental restoration and resource management issues. The Secretary of the Department of the Interior is required by March 31, 2012 to decide if implementation of the settlement agreements (1) will advance restoration of the salmonid fisheries of the Klamath Basin; and 2) is in the public interest.

1.1 Secretarial Determination

Two alternative management scenarios before the Secretary of the Interior must be addressed in the Secretarial Determination:

- **Conditions with Dams (Current Conditions)**: No change from current management including current laws and regulations;
- **Conditions without Dams and with KBRA (Proposed Action)**: Removal of the lower four Klamath River dams that are part of the Klamath Hydroelectric Project and implementation of the full range of actions/programs of the KBRA.

To evaluate the impacts of these alternative scenarios on native fish resources in the Klamath River Basin, the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) determined that existing and new scientific information regarding native fishes and environmental conditions must be reviewed and evaluated by expert panels, followed by peer reviews of the expert panel work products. Consequently, four expert panels were created to address native fish issues as they are impacted by the two alternative scenarios. These four panels are: 1) Lamprey; 2) Resident Fishes; 3) Coho Salmon/Steelhead; and, 4) Chinook Salmon. This report presents the findings of the Coho Salmon and Steelhead Expert Panel (Panel).

1.2 Expert Panel

At the request of the USFWS, Atkins (formerly PBS&J) convened an independent expert panel to evaluate the potential effects of the two alternative scenarios on coho salmon (*Oncorhynchus kisutch*) and steelhead (*Oncorhynchus mykiss*) in the Klamath River Basin. In order to ensure that the panelists and their work products were not biased, it was Atkins' responsibility to:

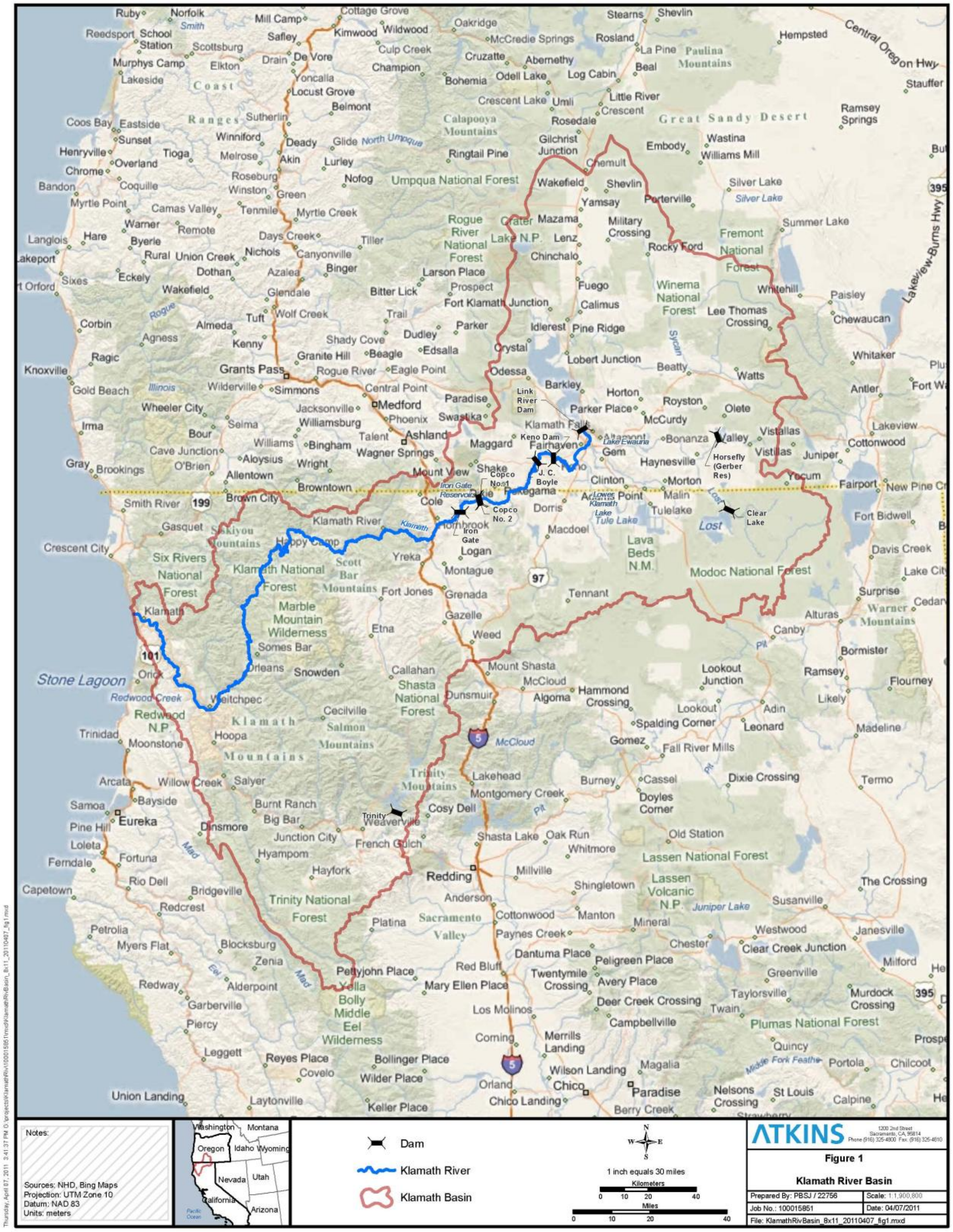

Figure 1. Klamath River Basin.

Figure 2. Klamath Hydroelectric Dams.

1) manage the process in which panelists were screened and selected; 2) facilitate the Panel deliberations; and 3) assist with the preparation of the Panel's conclusions in a report to the USFWS.

Through existing contacts and referral networking, Atkins identified a pool of almost 60 potential panelists. Prior to commencing the screening process, Atkins had no working relationship, and only limited direct knowledge of the panelists' expertise or professional affiliations. Attempts were made to contact all potential candidates for the Panel. The goal was to provide a panel of six experts. The Panel was designed to include an ecohydrologist, fish ecologist, fish population modelers, and experts on coho salmon and steelhead ecology.

Three additional criteria required of each panelist were:

- Ability to meet the timeframe for the review process;
- Ability to provide an expert review that would be widely regarded as both credible and independent; and,
- Candidates had to be free from potential or perceived conflicts of interest.

Brief biographies for each of the panelists selected for the coho salmon and steelhead expert Panel are as follows (full resumes have been provided previously to the USFWS and are included in Appendix A):

- **Dr. Wim Kimmerer**, Research Professor at the Romberg Tiburon Center, San Francisco State University, has a PhD in Biological Oceanography from the University of Hawaii. Dr. Kimmerer has 30 years of experience in research and analysis in a wide variety of topics including the ecology of tropical lagoons, fisheries management planning, eutrophication, plankton ecology, and the status of Chinook salmon (*Oncorhynchus tshawytscha*) in California's Central Valley. His current research focuses on the San Francisco Estuary, with emphasis on effects of human activities on the estuarine ecosystem. Dr. Kimmerer was a member of the CALFED Ecosystem Restoration Program Core Team which developed a strategic plan for the program, and was co-Chair of the Ecosystem Restoration Program Science Board. He is a science advisor to the Delta Science Program and to the Subtidal Habitat Goals Project.
- **Dr. Kenneth Rose**, E.L. Abraham Distinguished Professor of Louisiana Environmental Sciences, Department of Oceanography and Coastal Sciences, Louisiana State University, Baton Rouge. He received his PhD in Fisheries from the University of Washington. Dr. Rose develops and evaluates population and community models of fish, including age-, stage-, and individual-based models. Dr. Rose has published over 100 papers on various aspects of ecological and fisheries modeling. He has served on many regional and national advisory committees, including the NRC committee on a sustainable San Francisco Delta, the Ecosystem Management committee for the Gulf of Mexico Fisheries

Management Council, and multiple review panels for biological opinions and reasonable and prudent alternatives related to salmonids in the San Francisco estuary.

- **Dr. Daniel Goodman**, Professor, Ecology Department, Montana State University, Bozeman. He received his PhD from Ohio State University in 1972. His primary research area is parameter estimation for use in probabilistic environmental models, with applications in population viability analysis for endangered species, and management of harvested populations.
- **Dr. Joe Ebersole**, Research Fishery Biologist, U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Western Ecology Division, Corvallis, OR. He received his PhD from Oregon State University where he is currently a courtesy faculty member with the Departments of Fisheries and Wildlife and Environmental Science. Dr. Ebersole conducts research on stream fish ecology, with a recent focus on the behavior, distribution, and survival of fishes in stream networks.
- **Dr. Thomas Dunne**, Professor, Donald Bren School of Environmental Science and Management, and Department of Earth Science, University of California, Santa Barbara. He received his PhD from The Johns Hopkins University. Dr. Dunne conducts field and theoretical research in fluvial geomorphology and in the application of hydrology, sediment transport, and geomorphology to landscape management and hazard analysis. He is an internationally recognized expert in fluvial geomorphology with dozens of publications to his credit and has served on over 40 national and international science committees.
- **Dr. Greg Ruggerone**, Vice President, Natural Resource Consultants, Inc., Seattle, Washington. Dr. Ruggerone received his PhD in Fisheries from University of Washington where he is currently an affiliated research scientist with the School of Fisheries. Dr. Ruggerone brings 30 years of experience in anadromous fisheries ecology and management to this project. He has conducted applied research in salmonid predator-prey interactions, species competition, climate change effects on salmon production in the ocean, effects of habitat changes on salmonid production, limnological studies, effects of hydropower operations on downstream smolt and upstream adult migrations, and harvest management. He has participated in extensive field studies in applied fisheries biology and management in Alaska and the Pacific Northwest.

The opinions presented in this report reflect those of the panelists and not the views of their respective employers or professional affiliations.

1.3 Review Process

Atkins was awarded the contract to conduct the expert panel work for all four panels on June 15, 2010. At that time, Atkins' staff began assembling a pool of potential candidates for the coho salmon and steelhead panel. The initial review schedule for this panel was delayed by the USFWS in early August. The final expert Panel was confirmed on November 8, 2010.

Background files were provided by the USFWS and submitted to the Panel for review as they became available beginning November 18, 2010. The Panel convened for meetings in Yreka, California, from December 13 through 17, 2010. The first day of the meeting (December 13) consisted of briefings provided to the Panel by members of the Technical Management Team (TMT) subgroups, whom include scientists with expertise in a variety of technical disciplines relevant to the review process, as well as interested stakeholders. The Panel worked on this report in private for the remainder of the week.

During the course of their work the Panel relied on numerous documents as cited in this report. Key documents reviewed by the Panel included:

- Presentations from the TMT subgroups and stakeholders on December 13 (referenced in the text by author's last name and "PPT Presentation 12/13/2010");
- KHSA, February 18, 2010;
- KBRA, February 18, 2010;
- Synthesis of the Effects of two Management Scenarios for the Secretarial Determination on Removal of the Lower Four Dams on the Klamath River, Final Draft dated November 23, 2010 (Hamilton et al. 2010);
- Evaluation of Instream Flow Needs in the Lower Klamath River, Phase II Final Report (Hardy et al. 2006);
- Upper Klamath Basin Restoration: KBRA Actions upstream of Keno (Barry 2010);
- Endangered and Threatened Fishes of the Klamath River Basin: Causes of Decline and Strategies for Recovery (NRC 2004);
- Hydrology, Ecology, and Fishes of the Klamath River Basin (NRC 2008); and,
- Articles published in the scientific literature and agency reports.

During the meeting, each panelist took responsibility for specific sections of this report and provided a draft of their text to the other Panel members. Atkins' staff facilitated the meeting but provided no substantive technical input. By the completion of the meeting, an initial draft version of the Expert Panel Report had been reviewed and generally approved by each Panel member. The draft version of the report was then revisited by the Panel after the meeting, and a final draft was prepared and posted for stakeholder and agency comment on January 8, 2011. Through a separate, independent scientific peer review process, the draft report was also submitted to two independent reviewers for comment. Comments on the draft report were received through January 25, 2011. Additional comments were received late on January 28, 2011. All comments were carefully cataloged, reviewed, and responded to, as appropriate, by the Panel to create this final report. A complete list of all comments received on the draft report, along with the Panel's responses, is provided as Appendix C to this final report.

1.4 Panel Role and Nature of Report

The Panel was asked to make a scientific assessment of the relative impacts of the two alternatives on coho salmon and steelhead of the Klamath River Basin (excluding the Trinity River).

A wide variety of information is available on the life history of coho and steelhead, and the types of habitats used by these fishes in the Klamath Basin. The timeliness, quality, and utility of the information available to the Panel was highly variable. Relative trends in abundance are known for coho salmon and steelhead for some locations within the system. Some factors affecting population trends have been described, as discussed below, but the relative importance of respective factors or mechanisms that affect fish survival is less well known. Many factors affect fish survival and abundance, and the influence of such factors is often synergistic and nonlinear. Thus, projections of future abundance trends in response to management actions have inherent uncertainties, which are further amplified by fluctuating environmental conditions, economic and technological developments, and longer-term shifts in river and ocean habitat quality caused by climate variation and change.

Some quantitative and qualitative information on physical habitat characteristics within portions of the Klamath Basin have been described, including river flows, tributary conditions, water quality, water temperature, and geomorphology. The future condition of these physical and chemical variables will depend on drivers such as regional climate variation and change, the stochastic nature of weather and hydrology, regional economic and land-use change, and evolving political and regulatory philosophies of natural resource management. For evaluation of the Proposed Action, the Panel relied, to the extent that it thought it could, upon projections by agencies and consultants of how the physical attributes of the watershed might change in response to dam removal, habitat restoration activities, and climate change, even though many aspects of the Proposed Action (i.e., Fisheries Program, Drought Program, Phase II KBRA) have yet to be described. Phase I KBRA describes many goals for habitat restoration, including some general types of restoration projects. The KBRA describes general approaches to improve fish habitat, but details of how each activity might influence the specific life stage or species of fish have not been defined. Likewise, some restoration activities have improvement of water quality as a goal.

The key challenge for the Panel, therefore, was to evaluate the physical and biological information provided by agencies and stakeholders, to merge this information with the knowledge base that the Panel brings to the subject, and to logically describe potential outcomes of the two alternatives. The Panel members bring to the process their general knowledge of fish biology, lake and river characteristics and behavior, and their experience in environmental analysis in other systems including those that have been disturbed or actively managed. Their method of assessment involves assimilating the agency-supplied material together with some limited number of original documents and computational models used as the basis for the agency and consultants' reports. The Panel members can also supply their knowledge of other literature and case studies of similar issues elsewhere. The Panel did not have the time or resources to examine original data or re-do analyses, even when such actions seem straightforward and warranted for the assigned task. Thus, the analytical method of the Panel involves assessing and interpreting the likely reliability and relevance of the technical information supplied to them, evaluating its relevance to the biology of target fish, and estimating the impacts of the two alternatives on coho and steelhead that are highlighted by the questions about potential change in abundance and harvest based on the best available information.

The findings presented in this report represent the collective opinion of the Panel developed within a five-day workshop involving discussions and evaluations of the provided materials followed by subsequent email exchanges. The assessment as conducted by this Panel combined qualitative and quantitative information with professional experience to estimate potential outcomes of the two alternatives, which in turn allowed the Panel to at least partially address the assigned questions. Over and above the value of the Panel's estimation, recommendations in this review can serve as a guide for systematic data collection to reduce uncertainty in the future.

Table 1. Summary of Klamath Basin Fisheries Program Milestones. Note that many of the draft documents listed below are to be completed by agencies in the future and were not available to the Panel during their review.

Year	Milestones and Actions
2010	• Klamath Basin Restoration Agreement signed on 18 February (effective date). • Final Drought Plan by November 30 (not completed on schedule). • **Coho/Steelhead Expert Panel met 13-15 December.**
2011	• Draft Phase I Fisheries Restoration Plan by 18 February. • Draft Fisheries Monitoring Plan by 18 February. • Draft Phase I Oregon Fisheries Reintroduction Plan. • Initiate reintroduction activities in Oregon.
2012	• Initiate assessment of risks and potential impacts of climate change on management of Klamath Basin Resources. • Finalize NEPA for Phase I Fisheries Restoration Plan by 31 March. • Finalize CEQA for Phase I Fisheries Restoration Plan by 31 March. • Final Phase I Fisheries Restoration Plan by 31 March. • Final Fisheries Monitoring Plan by 31 March. • Detailed Plan for Facilities Removal on for before 31 March. • **Secretarial Determination made by 31 March**.
2013	• Final Phase I Oregon Fisheries Reintroduction Plan. • Draft Phase I California Fisheries Reintroduction Plan (presumed). • Dam Removal Entity (DRE) develops Definite Plan for Dam Removal (presumed).
2014	• Final Phase I California Fisheries Reintroduction Plan.

Table 1. Summary of Klamath Basin Fisheries Program Milestones. Note that many of the draft documents listed below are to be completed by agencies in the future and were not available to the Panel during their review.

Year	Milestones and Actions
2019	• Draft Phase II Fisheries Restoration Plan complete.
2020	• Target date to begin decommissioning the facilities is 1 January. • Target date for completion of facilities removal is 31 December, at least to a degree sufficient to enable a free-flowing Klamath River allowing volitional fish passage. • Review of fisheries outcomes by 30 June and recommendations for additional measures, if needed.
2020-2021	• Keno Dam fish passage improvements occur.
2022	• Final Phase II Fisheries Restoration Plan by 31 March.
2022	• Finalize NEPA for Phase II Fisheries Restoration Plan by 31 March.
Post-2022	• Draft and Final Anadromous Fish Conservation Plans to be developed by ODFW. • Draft and Final Phase II Fisheries Reintroduction Plan to be developed by ODFW.
2030	• Review of fisheries outcomes by 30 June and recommendations for additional measures, if needed.

Source: KBRA

2.0 Background

2.2 Alternatives

The two alternatives being considered by the Secretary of the Interior is described in detail here, along with what the Panel understood (based on information provided) was included within each of these alternatives.

2.2.1 Conditions With Dams (Current Conditions)

No change from current management, which includes on-going programs under existing laws and authorities that contribute to the continued existence of listed threatened and endangered species, as well as species relied upon for ceremonial, subsistence, and commercial purposes by the Native American Tribes of the Klamath Basin (The Yurok, Hoopa, Karuk, and Klamath Tribes), hereinafter Tribal Trust species. The Panel understood the Current Conditions to include:

1. Continued operation of the Klamath Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2082) in the same manner it is currently operated without any new operating requirements related to the relicensing of the project by FERC;
2. Requirements of the NMFS Biological Opinion (BO) for coho in the Klamath Basin
3. Implementation of Non-Interim Conservation Plan (ICP) Interim Measures;
4. Implementation of the Upper Klamath Lake Drainage Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP), as required by the Oregon Department of Environmental Quality (ODEQ) (ODEQ 2002);
5. Implementation of the Action Plan for the Klamath River TMDLs addressing temperature, dissolved oxygen, nutrient, and *Microcystis* impairments in the Klamath River in California and Lower Lost River, as required by the California North Coast Regional Water Quality Control Board (NCRWQB 2010);
6. Various fishery management plans prepared by the ODFW and the California Department of Fish and Game (CDFG); and
7. Effects of climate change on streamflow for the Klamath River watershed; predictions of these effects were presented to the Panel by Greimann (PPT Presentation 12/13/2010).
8. Implementation of ongoing restoration actions including (from Stillwater Sciences 2010):
    - In the mainstem Klamath River: floodplain rehabilitation, large wood installation, cattle exclusion, and gravel augmentation downstream of Iron Gate Dam.
    - In the Klamath River tributaries: floodplain rehabilitation, large wood installation, cattle exclusion, fish passage, conifer forest support, fire treatment,

conservation easements and land acquisition, road decommissioning, erosion and sediment control, obtaining minimum flows, and instream flow studies.

2.2.2 Condition Without Dams and With the KBRA (Proposed Action)

Removal of the lower four Klamath Hydroelectric Project dams (Iron Gate, Copco 1, Copco 2, and J.C. Boyle), and the full range of actions to implement the KBRA. The Panel understood the Proposed Action and the KBRA to include:

1. Removal of the four dams and reservoirs listed above together with improvements in fish-passage facilities at the remaining Keno and Link River dams, thereby opening the Klamath River to fish access upstream in the mainstem river as far as Keno Dam, and possibly farther if fish are able to negotiate upstream obstacles and seasonally unfavorable conditions.

2. Implementation of various KBRA restoration actions listed in Appendix C-2 of the KBRA. These actions include water quality remediation actions, aquatic and riparian habitat restoration, water conservation and water rights acquisition, addition of large wood and gravel, channel and floodplain reconfiguration, erosion control, and improvements to fish passage (including at Keno Dam). Available detail regarding these actions (where they would occur and the miles or acres of area treated) is summarized by Stillwater Sciences (2010) for the watershed downstream of Keno Dam (Table 2) and by Barry (2010) for the upper Klamath Basin watershed upstream of Keno Dam (Table 3).

3. Implementation of ICP Interim Measures.

4. Implementation of the two TMDLs cited previously; and

5. The effects of climate change on streamflow for the Klamath River watershed; predictions more or less as presented to the Panel by Greimann (PPT Presentation 12/13/2010).

Table 2. KBRA Restoration Needs for the Klamath Basin Downstream of Keno Dam.

KBRA Activity	Mainstem	Tributaries
Floodplain Rehabilitation (miles of channel)	2	13.27
Large Wood Placement (miles of channel)	63	198
Cattle Exclusion (miles of river)	146	153
Conservation Easements, Acquisitions (acres)	1,176	21,800
Gravel Augmentation (downstream of Iron Gate Dam)		
Fish Passage (number of sites)	0	73
Riparian Planting (acres)	0	346
Conifer Forest Management (acres)	0	7,945
Fire Treatment (acres)	0	116,050
Road Decommissioning (miles)	0	1,330
Treatment of Sediment Sources (projects)	0	240

Source: Stillwater Sciences 2010

Table 3. KBRA Restoration Needs for Klamath Basin Upstream of Keno Dam

	Miles, Riparian Acres (Along Stream Banks), or Number of KBRA Activity										
	Williamson River		Sprague River		Wood River				Upper Klamath Lake		
						Tributaries					
KBRA Activity	Mainstem	Tributaries	Mainstem	Tributaries	Mainstem	Sevenmile Creek/Canal System	Fourmile Creek/Canal System	Others	Upper Klamath/ Agency Lake	In or Above Keno Reservoir	TOTAL
Fence Construction and Offstream Watering (Miles)	50	4.4	130	76	25	6	1	26	–	–	318.4
Maintain Existing Fences, Manage Weeds and Exotic Plants (Miles)	112	10	220	132	42	46	16	38	–	–	616
Riparian Corridor Management Agreements (Acres)	1,386	91.2	6,202	1,897	720	175	–	–	–	–	10,471.2
Levee Removal, Setback, or Breaching (Miles)	2	–	30	16	3	–	–	–	–	–	51
Physical Habitat Improvements[1] (Miles)	12	5	22	15	15.4	–	–	7	–	–	69.4
Native Vegetation Management (Acres)	5,500	–	–	–	–	–	–	–	–	–	5,500
Improve Quality and Connectivity of Endangered Sucker Nursery Habitats[2] (Acres)	5,500	–	–	–	–	–	–	–	–	–	5,500
Channel Narrowing (Miles)	–	2.1	–	–	–	–	–	–	–	–	2.1
Grazing Management[3] (Full-Time Equivalent)	–	–	1 FTE	–	1 FTE	–	–	–	–	–	2 FTE
Improving Dryland Range to Reduce Need for Riparian Pastures (Acres)	–	–	19,000	–	–	–	–	–	–	–	19,000
Whole Channel Reconstruction (Miles)	–	–	15	10		4.5	2.3	3	–	–	34.8
Spring Improvement, Enhancement, and Reconnection[4] (Number of Springs)	–	–	20	20	–	–	–	–	–	–	40
Barrier and Impediment Removal (Number of Impediments)	–	–	2	6	–	–	–	–	–	–	8
Treatment Wetlands for Irrigation Drainwater (Number of Wetlands)	–	–	–	3	–	–	–	–	–	–	3
Floodplain Wetland Restoration and Storage[5] (Mile)	–	–	–	–	–	–	–	–	10		10
Enhance Endangered Sucker Spawning Habitat in Springs[6] (Number of Spawning Sites)	–	–	–	–	–	–	–	–	10		10

Table 3. KBRA Restoration Needs for Klamath Basin Upstream of Keno Dam

	Miles, Riparian Acres (Along Stream Banks), or Number of KBRA Activity										
	Williamson River		Sprague River		Wood River				Upper Klamath Lake		
						Tributaries					
KBRA Activity	Mainstem	Tributaries	Mainstem	Tributaries	Mainstem	Sevenmile Creek/Canal System	Fourmile Creek/Canal System	Others	Upper Klamath/ Agency Lake	In or Above Keno Reservoir	TOTAL
Study of Management and Reduction of Organic and Nutrient Loads	–	–	–	–	–	–	–	–	–	1	1
Implement Recommended Organic and Nutrient Reduction Actions[7]	–	–	–	–	–	–	–	–	–	Yes	–
Restore Wetlands on Keno Reservoir	–	–	–	–	–	–	–	–	–	TBD from Study	–
Screening Pumps and Diversions [8] (Number of Diversions)	–	–	–	–	–	–	–	–	–	Yes	–
Screening Pumps and Klamath Irrigation Project Diversions[9]	–	–	–	–	–	–	–	–	–	Yes	–
Acquisition of 30,000 acre-feet of water	Focused in the Sprague River, but acquisition could occur in any of these streams.										

Notes:
[1] Physical Habitat Improvements include treatments of large wood and gravel placement to maximize productivity and capacity for early life stages of anadromous fish to facilitate reintroduction.
[2] Includes future earthwork and other activities directed at the Lower Williamson Delta.
[3] Covers one Full Time Equivalent (FTE), defined as one grazing management specialist, 5 years full-time, part-time thereafter, to assist landowners with developing ranch management plans and maintain/enhance riparian corridor.
[4] Includes revegetating and reconstructing outlet channels, substrate treatments, and morphological changes to spring ponds.
[5] Targeted miles of lake fringe wetlands restoration to include removal of levee material and re-use for habitat features such as raised channels or island habitats.
[6] Targeted number of spawning sites to include gravel augmentation.
[7] Actions will likely be a combination of treatment wetlands, engineered water treatment facilities, physical removal of particulate organics, and treatments to precipitate nutrients.
[8] A total of 100 diversions targeted along Williamson, Sprague, and Wood Rivers; 20 diversions targeted at Upper Klamath Lake
[9] Studies are underway.
Source: Barry 2010

2.3 The Questions Put to the Panel

Three sets of questions developed by the TMT and stakeholders were provided to the Panel. These consisted of general questions as well as questions specific to coho salmon and steelhead. Because the Panel's assignment was to assess the effects of the two alternatives on coho and steelhead, the Panel addressed the general questions from a viewpoint that focused on these two species. Question S-8 regarding the effects of drought on steelhead was removed from consideration by the USFWS because the drought plan has not yet been developed (John Hamilton, pers. comm., December 15, 2010).

The original set of questions included background information and commentary (Appendix B). Questions are presented below with the introductory commentary removed. Also, several of the questions were relatively similar between lists for coho and steelhead, in which case the responses to the questions have been combined (Table 4).

In combining questions, the Panel restated most of the questions listed above for two purposes. The first was to restate the questions so they applied more generally. For example, one question from each of the lists applied to habitat (Table 4); by restating these as a single, more general question the Panel was able to address the entire issue of habitat with a minimum of repetition. The second purpose of restating the question was to remove redundancy regarding outcomes. The questions have been condensed accordingly in Section 3.1-3.13. One question on uncertainty (C-10) is discussed in a general section under that topic (see Section 4.2).

Table 4. Comparison of Report Sections, Topic, and Original Questions Posed to the Panel

Report Section	Topic	Original Question*
3.1	Sedimentation Management and Physical Habitat	S-5, G-1
3.2	Temperature	C-3, S-3, G-3
3.3	Water Quality	G-2
3.4	Adult/Juvenile Migration	C-7
3.5	Tributary vs. Mainstem Spawning	C-8
3.6	Access to Habitat	C-1, S-1, G-4
3.7	Refugia	C-2, S-2
3.8	Habitat Restoration	S-7, G-4
3.9	Ecosystem Function	C-5, S-9, G-10
3.10	Disease	C-6, S-10
3.11	Hatchery Operations	C-9
3.12	Recreational Fishery	S-6, G-6, G-7
3.13.1	Habitat Restoration (KBRA)	S-7, G-4
3.13.2	Diversity of Population Structures	G-8
3.13.3	Population Spatial Structures	G-9
3.13.4	Climate Change	C-4, S-4, G-5
4.2.1	Uncertainty	C-10

* Capital C, S, and G refer to coho, steelhead, and general questions respectively (Appendix B).

2.3.1 General Questions

G-1) Sediment Management and Physical Habitat: How will alternatives affect the sedimentation regime and physical habitat in the short-term (1-2 years) and over the 50-year period of interest?

G-2) Water Quality: How will the two alternatives differ in reaching the goal of harvestable fish populations?

G-3) Water Temperature: What are the likely effects of the water temperature regimes under the two alternatives on rearing, spawning, and use of thermal refugia by native salmonids that might be manifest in harvestable fish?

G-4) Habitat and Restoration (KBRA): The two proposed alternatives will result in different paths and timelines for habitat management. What are the likely effects of the two alternative habitat management paths on the recovery of Endangered Species Act (ESA)-listed fish or in the level of harvest of fish populations?

G-5) Climate Change: To what degree will the adverse effects of climate change be mitigated under the two project alternatives?

G-6) Abundance: How will the two alternatives affect abundance of the fish population and what are the expectations for the enhancement of the fisheries? This question may have several milestones along a timeline or population trajectory. For example, inasmuch as some fish populations have been extirpated from the upper Klamath Basin for more than 90 years, when might fish be available for tribal ceremonial use within the upper Klamath Basin? Using a time trajectory, when will a sustainable fishery start and at what levels?

G-7) Productivity: What are the most likely expectations for productivity over time and what is the effect of productivity on the number of harvestable fish? What is the role of hatcheries in relation to productivity?

G-8) Diversity: What will the effect of the two alternatives be on diversity of fish populations? How will the resulting diversity be manifest in the harvestable population of fish? How will potentially low baseline populations and/or introductions of hatchery fish affect diversity under the two alternatives?

G-9) Spatial Structure: Will the two alternatives result in improved spatial structure of fish populations and to what extent is that improved structure likely to result in harvestable fish?

G-10) Ecosystem Restoration: How do the proposed alternatives address ecosystem function and connectivity sufficiently to recover the lost harvest opportunities of fish populations?

2.3.2 Coho-specific Questions

C-1) Given current and future restored conditions of this new habitat, in conjunction with KBRA actions, to what degree would access to this historical habitat likely affect coho populations? To what degree would access to this historical habitat contribute to the viability of Klamath Basin coho salmon populations?

C-2) Thermal Refugia: How will increased access to large cool-water areas such as Big Springs in the JC Boyle bypass reach and Project Reach (between Iron Gate Dam and Keno Dam) tributaries affect the future viability of the Southern Oregon Northern California Coastal Coho (SONCC) as a population?

C-3) Phase Shift in Seasonal Temperatures: How will the two alternatives differ in the effects on seasonal temperature patterns and coho life history strategies over the 50 year period of interest?

C-4) Climate Change: Given the presence of large cascade-type springs in the areas upstream the dams (e.g., J.C. Boyle), that may mediate the warming effects of climate change (Tague et al. 2008; Tague and Grant 2009), how will access to these reaches affect the viability of coho salmon populations? Overall, to what degree do you think the adverse effects of climate change will be mitigated under the two alternatives being considered and what is the likely effect on coho populations?

C-5) Ecosystem Function: Given the habitat predictions for salmonid populations under the two alternatives, what inferences can be drawn about the likely population response of coho in the 50 year period of interest? Are changes associated with dam removal and implementation of KBRA, which target restoration of salmonid populations and a more functional ecosystem, likely to increase coho populations?

C-6) Disease Effects to Coho Salmon: What are the likely conditions for fish health over the next 50 years under the two alternatives?

C-7) Migration of Adults and Juvenile Coho: How would the two alternatives affect habitat connectivity, survival of the various life stages of coho salmon, and the overall populations of coho salmon in the tributaries?

C-8) Tributary vs. Main-stem Spawning: Which of the two proposed alternatives offer the greatest opportunity to increase coho spawning returns in both the main-stem Klamath River and its tributaries?

C-9) Hatchery Effects: Under these two alternatives what would be the effects to wild coho populations and harvestable coho populations? Specifically, how might differences in hatchery operations affect coho local adaptation, fecundity, disease vulnerability and genetics under the two alternatives?

C-10) Uncertainty of Model Predictions: Please describe your assessment of the uncertainty associated with each of the alternatives relative to the long-term viability of coho populations in the Klamath River Basin.

2.3.3 Steelhead-specific Questions

S-1) Reintroduction and Access to Historical Habitat:

a. Have *O. mykiss* populations currently upstream of the dams retained the potential for an anadromous life history?

b. Given passive reintroduction and future habitat conditions with Dams out with the Klamath Basin Restoration Agreement (KBRA), to what degree would access to this historical habitat likely contribute to sustaining or expanding steelhead populations?

c. How would these potential returns of steelhead compare to present returns to Iron Gate Hatchery?

S-2) Thermal Refugia: To what degree will upstream thermal refugia benefit steelhead in the basin?

S-3) Phase Shift in Seasonal Temperatures: How will the two alternatives differ in the effect on seasonal temperature regime timing and what are the expected effects on steelhead populations over the 50-year period of interest?

S-4) Climate Change: How will the two alternatives affect steelhead in the Klamath River?

S-5) Short -Term Effects of Dam Removal Downstream from Iron Gate Dam: How long would it take for recovery of main-stem steelhead populations downstream of Iron Gate Dam following dam removal? How might this affect low populations of summer steelhead?

S-6) Expansion of Recreational Fishery: Which of the two management options has the greatest likelihood of expanding fishing locations and the length of seasons for steelhead? Above Iron Gate Dam, where would fisheries for steelhead be most likely to develop?

S-7) KBRA Habitat Restoration: How will the two alternatives differ in the effects on productivity, capacity, and habitat connectivity for steelhead?

S-8) Drought Conditions: Would the two alternatives have different effects on the frequency, magnitude, and duration of low flows? If so, what are the likely effects of the differing low flow regimes on populations of steelhead?

S-9) Ecosystem Function and Riverine Processes: Which of the two alternatives will provide the most opportunities to provide a normative Klamath River and what will be the likely effects on the steelhead populations?

S-10) Fish Disease: What are the expected effects, both short and long term, of dam removal and implementation of KBRA on fish disease (other than *C. shasta*) and what affect might it have on steelhead populations?

3.0 Questions and Responses

3.1 Sedimentation Management and Physical Habitat (S-5, G-1)

Restated Question: How will alternatives affect the sedimentation regime and physical habitat in the short term (1-2 years) and over the 50-year period of interest?

Summarized Answers:

Current Conditions: Continuation of current level of restoration activities and flow regulation will provide very small, probably undetectable, benefits for the two species.

Proposed Action: Short-term effects of dam removal on sediment transport will be injurious to upstream migrating coho and steelhead, but longer-term prospects of dam removal with KBRA is an increase and expansion in spawning and rearing habitat – for steelhead probably considerably, and for coho probably slightly. Adverse effects of dam removal on juveniles will be restricted to those rearing in the mainstem, which should be a small percentage of the number of the juveniles, especially coho salmon, in the system.

Discussion:

Current Conditions will probably result in minor effects on sediment that are unlikely to have sufficiently large and enduring effects on the availability of habitat or on water quality for coho and steelhead (the intended targets of these two examples).

Dam removal will allow a small extension (likely about 10-20 percent) of spawning and rearing for both coho and steelhead into tributaries of the Project Reach[2], and probably in short, low-gradient reaches of the mainstem in the Project Reach. The augmented supply of gravel from dam removal and restoration of natural supplies should take a few decades to travel along the middle reach of the Klamath River between Keno Dam and Shasta River, and during its intermittent travel and storage, it will expand spawning habitat and trigger other channel changes that will add complexity to juvenile rearing habitat.

The fish will also be attracted to the cooling influence of large springs and more diffuse discharges of groundwater along the Project Reach. Thermal refugia are especially important to juvenile coho salmon when stream temperatures are warm. The outcome of interactions in refugial habitats between juvenile coho, steelhead, *O. mykiss*[3], and other species depends on a variety of factors, including fish size and density, and is difficult to predict.

The short-term effects of the sediment release will be sediment concentrations in the range of 1,000 to more than 10,000 milligrams per liter (mg/L), which will be injurious to upstream migrants of both species, and especially to any adult steelhead or "half-pounders" that hold or spawn in the mainstem. However, these high sediment concentrations are expected to occur for

[2] The Project Reach is defined in this report as that section of the mainstem Klamath River between Iron Gate Dam and Keno Dam.

[3] The Panel refers to steelhead in the report, and uses *O. mykiss* to refer to redband.

periods of a few months in the first two years after the beginning of reservoir lowering and sediment flushing. For a few years after that period, suspended sediment concentrations are expected to be higher than normal, especially in high flow conditions, but not injurious to fish. Sediment concentrations between the Project Reach and Scott River are expected to approach, but not exceed levels that have been observed in large natural floods in the lower Klamath and Trinity reaches, although the duration of turbidities high enough to be a nuisance to feeding fish will be greater than at present.

In the long-term, KBRA activities in the tributaries of Upper Klamath Lake will enhance flow and sedimentation and especially physical habitat quality, but will greatly benefit the fish only if the coho and steelhead can access the tributaries through Upper Klamath Lake. There is not strong evidence that coho previously migrated through Upper Klamath Lake (Hamilton et al. 2005).

Background

The physical habitat for fish in the Upper Klamath River Basin upstream of the Iron Gate Dam (drainage area 4,563 square-miles or 14,763 square-kilometers) is affected by the underlying geology. The Basin and Range in the most eastern, upstream part of the Klamath catchment consists of low north-south-trending, fault-bound mountain ranges separated by wide valleys. Sediments from the ranges have accumulated in the valleys, providing aquifers with significant groundwater storage potential, draining to lakes, marshes, or directly to the tributaries of the Klamath (Gannett et al. 2007). The High Cascade Province consists of high tablelands and wide, shallow valleys developed in the deep, permeable volcaniclastic deposits associated with geologically recent eruptions.

In both provinces, water from snowmelt and rainfall recharges the deep aquifers and travels to the stream network as groundwater, which enters the channels and lakes as both diffuse lateral inflow and in concentrated springs. As a result of the high permeability of these sedimentary and volcaniclastic aquifers, the density (and therefore total channel length) of the drainage network is low, and the rates of erosion and sediment supply (especially of mechanically resilient gravel) are all low. The rivers flow on low gradients, originally through broad marshy riparian zones that were sustained by the outcropping of water tables and provided productive fish rearing habitat.

However, extensive lowering of the water table through a combination of channel straightening and diking, and especially ground water extraction, has dried out these riparian zones and diminished their capacity for sustaining woody vegetation. This dewatering of the riparian zone is least intensive in the lowering reaches of the tributaries. The channels have been degraded further by grazing, browsing, and trampling mainly by cattle. This herd management impact has resulted in the addition of fine sediment to the stream channels, and the filling of some pools and springs with fine sediment.

The upper basin also contains approximately ten shallow lakes, the largest survivor of which is Upper Klamath Lake (area ~67,000 acres). Several other large lakes, some of which were originally more extensive than Upper Klamath Lake, have shrunk dramatically over the past century as a result of drainage, diversion, and consumptive use of water that formerly entered them. These changes degraded water quality in the streams and lakes of the upper basin.

Upper Klamath Lake has an average depth of about 6-8 feet (ft) or 1.8-2.4 meters (m) with local depths of up to 20-30 ft (6.1-9.1 m). The maximum depth of Upper Klamath Lake is 61 ft (18.6 m). In addition to distributed and concentrated inputs of groundwater, the lake is fed by two large tributaries: the Wood and Williamson rivers, the latter receiving much of its flow from the Sprague River.

3.1.1 Upper Klamath Lake Inflows

Inflows to Upper Klamath Lake determine the availability of water in the tributaries, the lake, and the Project Reach. Three aspects of the inflows to Upper Klamath Lake that provide a backdrop for evaluating the Proposed Action are: the pattern of monthly flows before the dams were constructed; the important role of ground water in the upper basin; and the frequencies of persistent periods of above-average or below-average annual inflows to the Upper Klamath Lake.

The aquifer-modulated tributaries, the storage in Upper Klamath Lake, and the former much larger storage of runoff in the other lakes and marshlands of the upper basin used to delay the timing of Klamath flow past the Keno and Iron Gate locations so that mean monthly stream flow peaked in April (Figure 3). Now, with the dams in place, stream flow peaks in March, before declining rapidly to 35-60 percent of the original unimpaired flow in the period May-July.

The inflow to Upper Klamath Lake is greatly influenced by ground water. The total inflow to Upper Klamath Lake is about 60 percent from the Williamson-Sprague system (NRC 2004), and about 16 percent from the Wood River. The headwater streams in the upper Williamson River are formed from rainfall, snow melt, and groundwater springs.

The modern seasonal pattern of water supply to Upper Klamath Lake from Williamson River has been monitored since 1918, before the rapid increase in agricultural development which began around 1950 (NRC 2008, p. 114). The record shows that the total annual supply from this river system exhibits persistent periods of low and higher supply. For example, the first 30 years of the record were, on average, lower than during the following 30 years (NRC 2008, Figure 4-11). This is a general characteristic of climatic and stream flow behavior in western U.S. hydroclimatic regions that are subject to the influence of enduring oceanic and atmospheric patterns such as the Pacific Decadal Oscillation (PDO) and the Southern Oscillation.

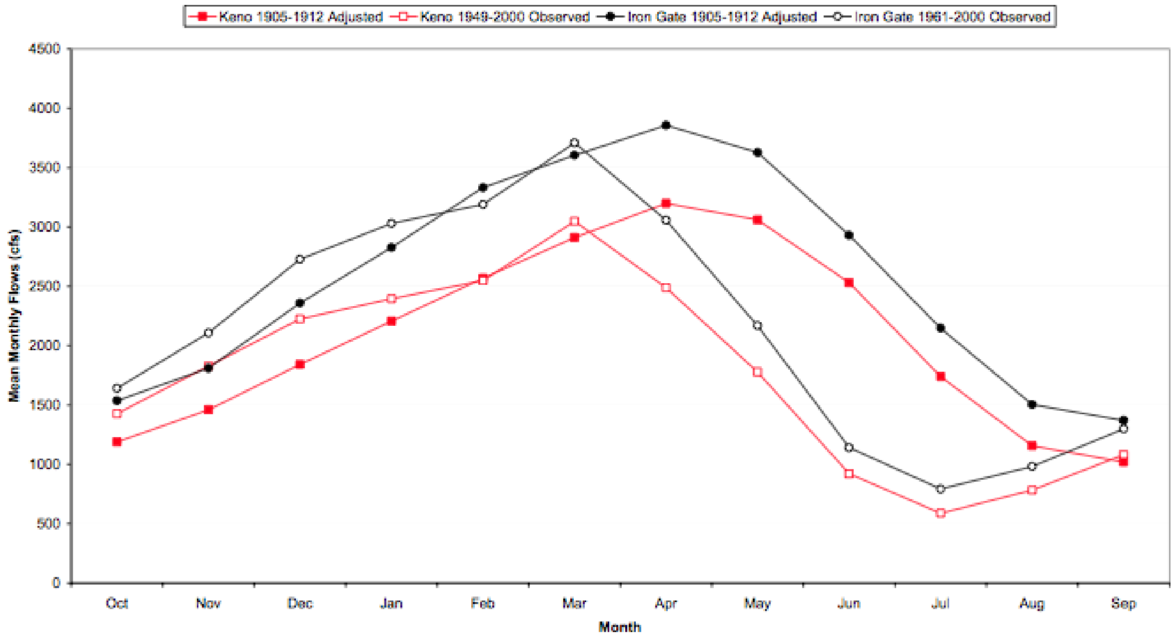

Figure 3. Estimated historical mean monthly flows at Keno and Iron Gate compared to the mean monthly flows at Keno (1949 to 2000) and Iron Gate (1961 to 2000) (From Hardy et al., 2006, Figure 4, p. 36).

3.1.2 Lake Levels

A significant hydrological characteristic of Upper Klamath Lake is its surface elevation, which fluctuates annually by about 3 ft (0.9 m) in near-normal years and by about 5 ft (1.5 m) in dry years. Its minimum level is now controlled at Link River dam. The upper range of lake level fluctuations that occur in the spring control the area of seasonally inundated lakeshore wetlands, which have been reduced in the past century by diking and drainage. These wetlands are considered to be favorable rearing habitat for resident juvenile fishes and to be a sink for nutrients. During late spring and summer, lake levels decline in response to decreasing tributary inflow, support of downstream flow targets, and agricultural withdrawals. In recent droughts, the level has fallen 2 ft (0.6 m) below the minimum elevation needed for inundation of lakeshore wetlands. The Proposed Action alternative is expected to produce slightly higher lake elevations in Upper Klamath Lake throughout the year compared with the Current Conditions (Figure 4). These higher lake levels will increase inundation of lakeshore wetlands that are used by larval and juvenile resident fishes (see Final Report for the Scientific Assessment of Two Dam Removal Alternatives on Resident Fish).

Figure 4. Average Monthly Flows and Upper Klamath Lake Elevations for the Current Conditions and Proposed Action Alternatives. (Source: Greimann PPT Presentation 12/13/2010)

3.1.3 Channel Habitat Upstream of Upper Klamath Lake

The western and southern arc of the Upper Klamath Lake basin is drained by spring-fed streams including Wood River and several smaller tributaries. These streams have reliable natural hydrographs of cold water [~12 degrees Celsius (°C)] but low sediment supplies. The springs and adjacent river channel beds tend to be covered with pumice rather than gravel. East side tributaries to Upper Klamath Lake provide relatively limited habitat for steelhead, and several are disconnected or dewatered, limiting access, although plans indicate a desire to reconnect some of these habitats (Huntington et al. 2006). Crystal Creek provides coldwater refuge for large *O. mykiss* in Pelican Bay, and could serve a similar function for steelhead and Chinook salmon (Huntington et al. 2006).

There is significant springwater contribution to the flow of upper Williamson River during the spring months, and water quality is generally good (supporting a world-class fishery for O. mykiss and historically supporting anadromous fishes); conditions in Wood River are similar (Hamilton et al. 2010; Huntington et al. 2006). The Sprague River is currently listed as water-quality impaired and shows serious habitat degradation throughout most of its lowland reach in the mainstem and both forks of the river, but before irrigation development it provided excellent habitat for anadromous fishes.

Under the Proposed Action, KBRA includes plans for aquatic habitat restoration in the Sprague, Wood, and Williamson Rivers and in Upper Klamath Lake (Table 4). Hetrick et al. (2009) estimated that over 420 (mi) (676) kilometers (km) of interconnected river and stream channels currently exist upstream of Iron Gate Dam that may provide functional spawning and rearing habitats for anadromous fish species with requirements that are generally similar to those of the resident fishes. Hetrick et al. (2009) further stated that Huntington (2006) reported that up to an additional 60-235 mi (97-378 km) of "potential habitat" exists in the Upper Basin that could be rehabilitated into a functional condition. The Panel could not confirm these statements about potential habitat, which are at odds with the field surveys from forty years ago by Fortune et al. (1966), who reported that only a small portion of accessible streams have suitable spawning and rearing habitat for salmonids. Fortune et al. (1966) conducted a relatively thorough on-the-ground survey of habitat availability and quality in these tributaries, and reported significant limitations on the area of spawning gravels because of the shortage of gravel supply from the catchment, and the widespread occurrence of pumice and silt. Other limitations on habitat quality included low dissolved oxygen, high temperatures between spring-fed reaches, some barriers to fish passage, and limited rearing habitat complexity. The discrepancy may depend on the meaning of the term "potential habitat" in the summary by Hetrick et al. (2009). If it means habitat that currently is of low quality but which *might* be upgraded with restoration activities, then the definition of the potential is largely a matter of economics, the willingness of riparian landowners to participate, and willingness of irrigators to sell their water rights. Huntington et al. (2006) repeatedly stressed that even the limited favorable reaches would require significant habitat improvements in order to support returning fish populations. Important components of these planned improvements are likely to be gravel augmentation and the reversal of past streamflow reductions through the restoration of 30,000 acre-feet of summer flows in as-yet-unspecified locations within the Upper Klamath Lake tributaries.

Apart from the lower reaches of the Williamson (roughly lower 10 mi or 16 km) and Wood rivers, and the upper reaches of the North and South forks of the Sprague River, the flow reduction and the degree of degradation are so intense that restoration to a "functional level" of spawning and rearing habitat will require substantial effort. For example, because of the geology of the basin there is a limited amount of spawning gravel, and therefore of bars and pools. The seasonal, and in some places long-term lowering of groundwater tables by diking, drought, and pumping extraction, has dried out riparian marshlands and does not support woody riparian vegetation in long lowland reaches. Riparian vegetation has also been removed through browsing by cattle. Fencing cattle away from the stream banks has led, in some places, to sufficient recovery of grassy riparian vegetation to reduce sediment input to streams, which will reduce phosphorus inputs to Upper Klamath Lake. Reduction of sediment input will probably also allow flows to deepen the pools and remove fine sediments from existing gravel bars, but the limitation on this process is likely to be the shortage of gravel in the channels and the resulting low amplitude of bars, which force flow across channels and increase the scouring of pools. There is significant potential for improving bar-pool habitat through gravel augmentation after quantitative analysis and project design. Also, it is not clear from the assessment reports how much recruitment of riparian woody vegetation or sedges is expected or needed to restore fish rearing habitat. The potential for improving stream temperatures through shading could be estimated by calculating the alteration of the radiation balance expected to result from whatever riparian vegetation is likely to colonize stream banks as a result of KBRA.

3.1.4 Channel Habitat Downstream of Keno Dam

The 43 mi (69 km) reach of the Klamath between Keno and Iron Gate dams is generally steep (gradient is ~0.0025-0.01), extensively confined by bedrock canyon walls, and has a sediment supply much lower than the river's transport capacity. Stillwater Sciences (2010) estimated from various sources that the sediment supplied to this reach comprised only 24,000 tons (t) of sand-gravel per year and 127,000 t of silt-clay. Thus, gravel bed-material storage on the free-flowing reaches between reservoirs is sparse, being confined to generally lower gradient reaches such as the Frain Ranch area [River Mile (RM) 218] and the mouths of the few tributaries. However, most of this bed material is in the 100-500 millimeter (mm) or 3.94-19.69 inch (in) range, and only 15-20 percent of it is in the range 10-100 mm (0.39-3.94 in).

Before impoundment, there was a distinctively low-gradient reach at the site of the Copco 1 Reservoir where the river flowed in a valley-wide meander belt through a floodplain containing old channel scars with varying degrees of connection to the current channel. The Frain Ranch reach also has a low gradient. Elsewhere, the free-flowing reach comprises long rapids, runs, and pools among large boulders. There was also a low-gradient reach at the site of J.C. Boyle Reservoir, but the sediment supply to this reach was, and will remain, very low.

Between the quiescent impoundments, the free-flowing reaches, especially the one between J.C. Boyle Dam and Copco Reservoir, have generally high velocities with rapid fluctuations of discharge between 350 and 2,400 cubic-feet per second (cfs) and of velocity during summer because of peaking power production. These fluctuations inundate the substrate with fast-flowing water and then dewater it on a daily basis. The Iron Gate Reservoir re-regulates these flows into a hydrograph that propagates some minor fluctuation several miles downstream during summer low flows, but is dominated by unreliable and highly variable late-winter peaks of 5,000-30,000 cfs and extended low flows regulated to at least 700-1,300 cfs during the rest of the year (Hardy et al. 2006).

Downstream of Iron Gate reservoir the river has a gradient of ~0.0025 and a cobbly surface with a subsurface median grain size in the 10-20 mm (0.39-0.79 in) range. The mainstem has a wandering habit with broad, irregular bends and occasional anastomosing side channels. The average annual sediment supply to this reach increases gradually with increasing distance downstream of Iron Gate as the river enters more erodible terrain, so some riffles and bars form in the relatively low-gradient reach beginning at the R-Ranch (approximately RM 187). However, the sediment supply remains low until it is strongly augmented at the Scott, Salmon and Trinity river confluences, which, despite heavy impacts by water withdrawals and other management actions, provide large sediment supplies to the Klamath. The sediment supply favors the development of more extensive bar, pool, and riffle habitat. However, the channel downstream of Iron Gate Dam is simple in form and wide enough to be essentially unshaded.

Coho and steelhead use the mainstem for upstream passage to spawning areas and for seaward migration of smolts. Only a relatively few steelhead and coho spawn in the mainstem, such as in the braided reach at the R-Ranch, and most juvenile coho and steelhead likely rear in tributaries, and juvenile coho avoid the mainstem during warm periods in July and August.

If dams remain in place, then the habitat conditions described above will persist with only subtle changes due to foreseeable hydrological changes. For example, some habitat improvements such as local gravel augmentation are already planned in a general way (no details on amounts or locations were supplied to the Panel) in both the Lower Klamath (unspecified as to whether this means the mainstem or the tributaries, but it most likely refers to the tributaries of the Lower Klamath), and in reaches between the reservoirs. Other habitat improvements are also planned in a general way under the KBRA that may gradually extend small areas of both spawning and rearing conditions in the sediment-starved impounded reach and spawning conditions in the lower river. The effects of persistent runs of wet and dry years, and of anthropogenic climate change that are described elsewhere in this document will occur whether dams are removed or not.

3.1.5 Hydrology and Geomorphology with the Proposed Action

Dam removal will have only small effects on the flood regime downstream of the Project Reach because the small storage volumes of the four reservoirs do not currently influence flood flows to any important degree. Peaking flows within part of the Project Reach will be abolished. Bureau of Reclamation predictions of Klamath River flows with dams removed and KBRA in place (B. Greimann PPT Presentation 12/13/2010, see Figure 4 above) illustrate an expectation of higher flows in April and July-September, followed by decreased flows in October-December. As far as the Panel can tell from the presentation materials, which were not documented in detail, these predictions, along with statistical estimates of deviations from the average, are based on a hydrological model of the basin's water yield under current land management and climate, but with some changes of water management. Hetrick et al. (2009) used a planning model to examine how changing water operations could provide more favorable habitat conditions for Chinook salmon. They used the 1961-2000 flow record of inflows to Upper Klamath Lake to illustrate the potential for KBRA operations to conserve water in the late fall and winter to provide higher spring flows for fry and juvenile rearing in the spring and early summer. These proposals are roughly similar to the predictions by Greimann (PPT Presentation 12/13/2010), although Hetrick et al. (2009) modeled longer periods of increased flow during late spring and early summer when juveniles are rearing in the main stem.

KBRA also involves plans for limiting the quantity of water diverted from Upper Klamath Lake and the Klamath River for the Klamath Irrigation Project. This limitation would result in the availability of water for irrigation being about 10 to 26 percent less than current demand in the driest years, with water availability for irrigation increasing on a sliding scale with increasingly wet conditions. The current pattern of agricultural water deliveries being higher in dry years than in wet years would be reversed. The Panel understands that the planning of such limitations is still at the conceptual stage with neither the sellers nor their locations identified. Under the Proposed Action, the KBRA can affect the channels in various parts of the potential species ranges, mainly through artificial reconstruction of within-channel habitat in the Upper Klamath Lake basin, and largely by restoration of a natural sedimentation regime downstream of Keno Dam. There are also some (unspecified) actions within KBRA that will alter the physical aspects of the channels in this lower basin, most likely within tributaries. The reconstruction activities will be emplaced and will have their influence over the time scale of decades. As discussed below, the changes in sedimentation will have both short-term and long-term consequences.

3.1.6 Short-term Effects of Sediment Release

Geotechnical surveys of the magnitude and grain size of sediments stored behind the four dams have documented approximately 8.1 million tons of impounded sediment, approximately 84 percent of which is in the silt-clay size range. Only 0.26 million tons are behind J.C. Boyle Dam, and the rest is distributed evenly between Copco 1 and Iron Gate reservoirs. Stillwater Sciences (2008; 2009; 2010) and the Bureau of Reclamation (Greimann et al. 2010) have estimated the fraction of this sediment that will be eroded out of the impoundment sites under various conditions of flow and reservoir management. Although there are important differences in the timing of the sediment releases among the various simulations that both groups have made and in their separate preferred release strategies based on engineering logistics and fish protection, the major results are consistent and in agreement with the qualitative interpretations made by earlier consultants (Ayres 1999; Shannon and Wilson 1999).

Stillwater Sciences (2008) predicted that a channel with assigned dimensions will cut down through the deposits in each reservoir at a rate that will depend on the weather-dependent water inflow rate and the rate of reservoir lowering (to be managed, but vulnerable to unpredictable flood flows) and the (low) concentration of sand and gravel in the deposit in each reservoir. Sediment from J.C. Boyle Reservoir will be flushed earlier and more completely than sediment from the lower reservoirs. It is likely that within the first year (or two if drought intervenes) 1.4-3.2 (~ 2) million tons of the sediment [consisting almost entirely of silt and clay but with perhaps 200,000-300,000 (10-15 percent) tons of sand] will be flushed downstream of Iron Gate. This would leave 60-83 percent of the sediment in place along the margins of the new channel that would require rapid re-vegetation under adverse soil and moisture conditions in order to avoid problems with invasive weeds and dust, as well as chronic erosion of fine sediment into the river. The predicted first-year total of flushed sediment is smaller than the total amount transported during major floods on the river, although the transport would occur over a much larger number of consecutive days and at much lower discharges in the dam removal case.

Assuming dam removal begins in November, the Stillwater modeling of deposit erosion predicts that fall and winter concentrations of sediment downstream of Iron Gate will range up to about 10,000 mg/L at Iron Gate (3,000 mg/L at Orleans), declining to 2,000 mg/L at Iron Gate (500 mg/L at Orleans). These are the seasons when adult coho, winter steelhead, lamprey, and green sturgeon are expected to be using the mainstem and when half-pounder steelhead are expected to be rearing in the mainstem (Stillwater Sciences 2009). The Oregon Department of Fish and Wildlife (ODFW 2010) suggested that most adult steelhead would hold in tributaries rather than the mainstem (based on observations in the Columbia River); most adult coho are destined for tributaries. Some juvenile salmonids would be in the mainstem during fall and possibly in winter. The sediment concentrations are computed to remain chronically within a range of several thousand to several hundred mg/L for periods of up to six weeks for two seasons at least (November-December and May-June) between periods of reservoir filling. These periods include a significant proportion of the time when juvenile steelhead and coho salmon would be moving downstream (Stillwater 2009; Greimann et al. 2010).

This silt-clay fraction is not currently represented in the channel bed downstream of Iron Gate Dam. It is expected that this "washload" following dam removal will be transported far downstream by even low flows, and will be flushed rapidly to the ocean by typical annual and larger floods. This reasonable approximation was used in the simulation model runs by Stillwater Sciences (2008; 2009; and, 2010), who also interpreted that there will also be some deposition of this fine sediment along the channel margins and in the floodplain that was not represented in the model simulations. The amount of this marginal sediment storage will be greatest in low-gradient, sinuous reaches of the Lower Klamath River. Analogous modeling by the Bureau of Reclamation (Greimann et al. 2010) has considered some important changes to preferred release strategies, based on engineering judgments about safety and construction management, but the implications for river conditions and biological effects are essentially the same as the Stillwater projections.

Fine sediments carried downstream have the potential to lower dissolved oxygen as a result of biochemical oxygen demand (BOD) of the carbon incorporated in the reservoir deposits, which averages about 5 percent by weight (Table 3 in Stillwater 2008). The degree to which this BOD reduces oxygen in the water column is under investigation (P. Zedonis PPT presentation 8/2/2010). However, water turbulence in the free-flowing river and input of oxygen rich water from tributaries should help reduce the potential effect of BOD on oxygen content of the river when sediment is released.

The flushing events will also involve considerable amounts of sand, some of which will be carried close to the bed and is likely to permeate the channel bed and reduce the quality of spawnable gravels. Calculations by Ayres Associates (1999) indicate that the channel bed in this reach should be mobilized by flood flows with recurrence intervals of about 2 years. However, sand will continue to emanate from the reservoir deposits for years after dam removal and the entire reach will not be flushed of sand within one or two high flow events, so it is likely to take more than a decade for the bed fining caused by dam removal to be reversed. Similarly, sand that is predicted to settle into some pools downstream of Iron Gate Dam will be scoured away in floods of 1-2 year frequency. This form of sand storage will be less damaging to juvenile rearing habitat than the distributed settling of sand into the gravel will be to the quality of spawning beds. However, most coho and steelhead reportedly spawn in tributaries and they would not be affected by sedimentation of gravels in the mainstem. Within the impounded reach the bed of J.C. Boyle Reservoir will be flushed more effectively and sooner than the beds of the other reservoirs. The buried floodplain on the bed of Copco 1 Reservoir, which included some attractively complex channel and off-channel habitat before impoundment, may need some dredging to recover former meanders and floodplain channels.

3.1.7 Long-term Effects of Sediment Release

After the first year or two, the chronically high turbidity will decline to much lower levels, continuing to be fed by slow erosion of the floodplain and banks of the new channels through the reservoir sites. As the dams are removed, there will no longer be reservoir filling periods to interrupt sediment flushing, which will thus be driven by the seasonal and storm runoff regime.

The fining of the channel bed by sand intrusion and coverage downstream of Iron Gate Dam will gradually be reversed, but not for decades as the sediment supply of sand from the reservoir is likely to require that time scale to stabilize. Calculations of the likely frequency of bed mobilization by Klamath River flows by Ayres Associates (1999) and Greimann et al. (2010) predict bed mobilization every few years in the reach between the Iron Gate Dam site and the Salmon River confluence, so the sand content of the gravel downstream of Iron Gate Dam will gradually diminish over a small number of decades.

Stillwater Sciences (2008) did not calculate the transport of gravel out of the reservoir, but acknowledged that it will occur much more slowly than even the sand transport. Most of the gravel in the reservoir deposits is likely to occur around the upstream and lateral margins of each deposit, and particularly at the mouths of tributaries, gullies and eroding alcoves. Thus, on average, gravel trajectories will begin farther from Iron Gate Dam than the finer sediment. Average annual transport distances of traced gravel particles in other rivers lie in the range of several hundreds of meters, but in this case the presence of significant sand and fine gravel in the source deposit, coupled with the generally high gradient of the Project Reach are likely to increase the average annual distance of transport. However, the gravel will not clear the Project Reach for many years after the dams are removed and will spread downstream only slowly. It is likely that this wave of gravel will be spread broadly across the channel and on lateral bars in the lower Project Reach (between Copco and Iron Gate dams) and in the first few miles downstream of Iron Gate Dam. Farther downstream, on the time scale of the first and later decades the mobile gravel is likely to augment the surface of riffles and bars, expanding the area of spawnable habitat and increasing the rate of bank undercutting, recruitment of large riparian wood fragments and the amount of juvenile rearing habitat over a relatively small proportion of the channel bed.

3.1.8 Future Habitat with the Proposed Action [Short-term and 50-year Prospect]

The immediate and simplest change in habitat resulting from the dam removal will be the opening of approximately 69 mi (111 km) of channel in the Klamath mainstem and the lower reaches of several tributaries between the Iron Gate and Keno dams. Because of the gradient and limited or patchy spawning habitat, some of the mainstem portion of this reach will serve primarily for facilitating passage between the few tributaries. A several-mile-long mainstem reach currently inundated by Copco 1 Reservoir has the potential for reconstruction of habitat, once its cover of sediment has been flushed away. The value of the mainstem habitat in the Project Reach for steelhead rearing is higher than for coho; there is presently a robust *O. mykiss* population (approximately 1,000 fish per mile) in the non-reservoir portions of that reach (PacifiCorp 2004; Carter and Kirk 2008). The ODFW (2010) suggests that some spawning habitat for steelhead is expected in the mainstem near Spencer Creek.

The Project Reach will continue to receive only a small amount of sediment because of the resistant rocks in this portion of the watershed and the proximity of Keno Reservoir and Upper Klamath Lake, which will continue to interrupt sediment supplies. The sediment supply will continue to be far less than the river's sediment transport capacity, and only the cobbles and coarsest gravel will travel slowly enough and intermittently so that they will be stored temporarily to provide a discontinuous substrate on the channel bed and some bars. Currently, the material on the bed in these reaches between reservoirs is mainly in the cobble-boulder range (Greimann et al. 2011). The most likely sites for significant, temporary sediment storage will be the several tributary junctions, the Frain Ranch reach, and about 4 mi (6 km) around the current site of Copco Reservoir, where a floodplain with active and abandoned meanders had created significant sediment storage and morphological complexity before impoundment. Both kinds of sites will probably also temporarily store small amounts of fine-grained sediment. Gravel augmentation, planned for some sites, will provide some expansion of gravel bars, but the river will continue to have a high capacity for transporting that gravel away from augmentation sites. Amounts of money currently envisioned in the ICP Interim Plan for this activity are sufficient to provide only several thousand cubic yards of gravel per year, which is a small amount relative to the river's transport capacity and relative to the extent of the valley floor in the currently impounded reach. Selection of low-gradient sites, such as the bed of the J.C. Boyle Reservoir, which currently receives almost no sediment, might be favorable for such gravel augmentation.

The extent of new habitat for coho and steelhead upstream of Upper Klamath Lake will depend on the success of these fish to travel through the lake and establish populations in the tributaries. Thus, it will depend on the success of KBRA restoration activities. The issue is discussed in Section 3.1.3. Hetrick et al. (2009) claim that 420 mi (676 km) of steelhead habitat, together with 60-235 mi (97-378 km) of "potential habitat," are available in the lake tributaries. However, the proportion of this potential that is likely to be realized is not yet clear from the planning for KBRA.

3.2 Temperature (C-3, S-3, G-3)

Restated Question: What are the likely changes in water temperature regimes under the two alternatives and their effects on rearing and spawning life history strategies?

Summarized Answers:

Current Conditions: The present temperature regime in the mainstem Klamath River is often near the warm limits for salmonid adults during July through September and near the warm limits for rearing during May through October.

Proposed Action: Daily mean temperature will be slightly warmer before and slightly cooler after August, with potentially positive and negative results for affected life stages. The Proposed Action has the potential to improve temperature conditions over those that will occur under the Current Conditions, although the net effects of temperature changes on coho and steelhead under the Proposed Action is not known due to both increased and decreased temperature across multiple life stages. Further consideration of the potential importance of within-day variation in temperature is warranted.

Discussion:

The coho question asserts that "under current conditions there has been a phase shift of temperature downstream of the Project of approximately 18 days due to the Project dams," and then asks how the two alternatives will "differ in the effects on seasonal temperature patterns and coho life history strategies over the 50 year period of interest."

First, we consider the premise of an "18 day phase shift." This is a modeling prediction from Bartholow et al. (2005), who used a modeling shell (called SIAM version 3.75) that links two component models: MODSIM which simulates flows with a monthly time step, and HEC-5Q which simulates temperature, evidently with a daily time step. The SIAM shell handles the "disaggregation" of the monthly flow outputs into daily values for input to HEC-5Q.

The model fitting and testing were carried out with data from 1962-2001 when all four dams in question were operating. The calibration and validation were conducted separately for MODSIM and for HEC-5Q. The reported validation error (mean absolute value discrepancy) for the flow model is on the order of one percent for the monthly means. However, the analysis did not seem to include an error rate at the level of the disaggregated daily mean flow values that are transmitted to the temperature model. The reported validation error (mean absolute value discrepancy) for the temperature model is on the order of 2°C for daily mean temperature (presumably using actual observed daily flow input). The analysis did not report validation of the integrated system in which the errors of the flow model propagate through the temperature model.

The reported validation was all internal to selected years in data sets with the dams in place, so it does not address reliability of the predictions with dams removed. The way the modeling represented the Proposed Action scenario was to reduce the "storage" for each removed dam to 1000 cubic-meters (m^3) (whereas the reservoirs have maximum storage volumes in the millions of m^3). Considering that the temperature model is one-dimensional, the ability of a section calibrated as a lake to represent the temperature dynamics of a river reach is not a foregone conclusion, and merits confirmation.

The "future scenario" was modeled by re-running 1962-2001 inputs (meteorology and inflow) with or "without'' the four dams in question (so the Current Conditions scenario is simply a hindcast). This does not address trends in climate change, scenarios of demand for water, or KBRA actions that might affect the water budget or temperature of inflows over the next 50 years.

For these reasons, the model prediction of an 18 day "phase shift" in the annual thermograph is not a sure thing, and probably should not be taken literally. Qualitatively, the prediction is plausible: elimination of the thermal storage in the four reservoirs will allow the affected river reaches to track air temperature more closely, resulting in some increase in temperature variability (higher highs and lower lows) and some shift toward earlier warming in the spring and earlier cooling in the fall.

If, for the sake of argument, we accept the model results at face value, the reported 18-day shift is the lag at which the lagged correlation is maximum between the Current Conditions and Proposed Action trajectories averaged over the 40-year trajectories. It is not clear whether this search for the lag with maximum correlation was for trajectories of daily values in the native output of the model or whether it was for trajectories of monthly averages, as graphed in Figure 4 of Bartholow et al. (2005). The shift differed for different seasons (longer in the fall, shorter in the spring and early summer), and differed considerably among years. Variances of the daily means were greater in the Proposed Action scenario (higher high days and lower low days for the daily means).

The January through mid-August monthly mean temperatures at the location of Iron Gate Dam are predicted to be warmer by up to roughly 2°C; and the mid-August through November monthly means are predicted to be cooler by up to roughly 5°C (Figure 4 in Bartholow et al. 2005). The effects attenuate with distance downstream from Iron Gate Dam.

This seasonal shift in daily mean temperature, if it materializes, would be good for salmon using the mainstem after August; this will include the coho and winter steelhead spawning migrations. Conversely, the predicted shift would be bad for salmon using the mainstem through August. Most returning summer steelhead would likely experience higher mainstem temperatures (Stillwater 2010). The very early portion of the adult winter steelhead run would also experience higher temperatures in July (see timing of return in Stillwater 2010), whereas the later portion of the winter run would experience cooler water under the Proposed Action (dam removal).

Against these comments on possible consequences of long-term seasonal averages of daily mean temperature, it must be noted that the fish do not directly experience these mean temperatures. The fish experience the hour-by-hour temperatures on each day. Regardless of the direction of shift in the daily mean water temperature owing to dam removal, the spread of temperatures between day and night, and the range of variation between warm days and cool days, will increase under the Proposed Action.

Therefore we can expect circumstances, for example, where even though the mean daily mean temperature for a period in the fall is decreased by dam removal, the highest temperatures experienced by the fish (warm hours of the day on warm days) will increase.

On the other hand, if the fish use cooler hours of the night for migrating in the mainstem from one thermal refuge to the next, the cooler cold hours and cooler cold days (during the warm season) under the Proposed Action could benefit the fish. Cooler fluctuating temperatures can also allow time for repair of proteins damaged by thermal stress, allowing persistence through periods of high maximum daily temperatures (Schrank 2003).

In other words, evaluating the net benefit or harm to fish from the temperature effects of dam removal as part of the Proposed Action will require more detailed information about the movement patterns of the fish and more detailed (and reliable) predictions of location-by-location and hour-by-hour thermal exposure of affected fish.

3.3 Water Quality (G-2)

Restated Question: How will the alternatives affect water quality in the Klamath Basin?

Summarized Answers:

Current Conditions: Water quality in Upper Klamath Lake and the reservoirs downstream to Iron Gate Dam will continue to be poor. Some improvement is possible because of non-KBRA activities.

Proposed Action: Water quality under the Proposed Action should generally improve over the conditions expected with the continuation of current conditions, but with unknown or likely small improvements in many of the water quality parameters. Water quality should improve between Keno Dam and Iron Gate Dam after dam removal. The limited detail provided in the KBRA suggests that minimal reduction in nutrient loading and small increases in dissolved oxygen levels upstream of Keno Dam are likely. *Microcystis* blooms are expected to diminish downstream of Keno Dam as a result of increased channel bed mobility and sand transport

Discussion:

The most important water quality issues occurring in Upper Klamath Lake and the reservoirs downstream of Upper Klamath Lake include low dissolved oxygen (DO), high ammonium concentrations, and the formation of blooms of cyanobacteria ("blue-green algae") including the noxious *Microcystis aeruginosa*.

Oxygen concentrations at Keno Dam went to zero at times during 1996-1998, but were never below 4 mg/L at Iron Gate Dam (Campbell 2001). Depression of dissolved oxygen in Upper Klamath Lake and the reservoirs is due to elevated oxygen demand caused by high levels of organic matter, mainly due to production by algae (Doyle and Lynch 2005) and to some extent due to high ammonium concentrations (Sullivan et al. 2010). Eutrophication (i.e. excessive production of organic matter) in Upper Klamath Lake and Keno Reservoir can be attributed to high nutrient loading rates. This kind of problem is common in water bodies receiving runoff from urban and agricultural areas (e.g., Chesapeake Bay). Paleolimnological evidence shows that sediment and nutrient loading to the Upper Klamath Lake and resulting biological productivity in the lake increased concurrent with increasing human settlement in the basin (Eilers et al. 2004). However, this paper also showed that the lake was eutrophic before European settlement, presumably as a result of high levels of nutrients naturally occurring in the watershed.

The limiting nutrient has been reported to change from nitrogen (N) in spring to phosphorus (P) in fall based on water-column concentrations (Campbell 2001); but large fluxes of P from sediments suggest an additional loading term (Kuwabara et al. 2009). Experiments with nutrient addition showed N limitation of growth for total phytoplankton and for the cyanobacterium *M. aeruginosa* from Iron Gate and Copco reservoirs during the summer (Moisander et al. 2009). This potentially toxic form was first reported in 2005 (Moisander et al. 2009). Blooms of the cyanobacterium *Aphanizomenon* have been large enough to support an industry harvesting about 1,000 metric tons annually for human consumption as a dietary supplement (Carmichael et al. 2000).

Blooms of *M. aeruginosa*, occur worldwide, and although generally they are understood to result from over-enrichment of nutrients, control strategies have been slow in coming (Paerl 1988). However, under Current Conditions, the *M. aeruginosa* blooms occur only in the reservoirs downstream of Keno Dam, presumably because of N limitation upstream of Keno Dam (Moisander et al. 2009). Since this species is intolerant of turbulent water, blooms will likely be eliminated by removal of the dams under the Proposed Action.

The measures proposed in KBRA to ameliorate hypereutrophication and blooms (Barry 2010) are inadequately described for quantitative evaluation by the Panel. Proposals include construction or reconnection of wetlands to remove nutrients. The description provided to the Panel (Barry 2010) says the restoration is "Likely to be combination of treatment wetlands, engineered water treatment facilities, physical removal of particulate organics, treatments to precipitate nutrients (alum, clay, etc.). Cost are certain to be large, precise estimates will follow appropriate studies." Although these suggestions, if carried out, could reduce nutrient loading and particulate matter in the lake, the "appropriate studies" necessary to determine the magnitude and cost and, most important, the likely effectiveness of this group of actions have not been done. Even a simple mass-balance calculation using crude estimates of the magnitude of restoration actions would bound the likely improvements. Experience from other locations where eutrophication is a major problem suggests that, at a minimum, drastic reductions in loading from the watershed must accompany local amelioration to be effective. These reductions must account for the apparently high natural nutrient inputs from the local watersheds, and the unavoidable leakage occurring in watersheds heavily altered for urban and agricultural use. Thus, it would be premature to conclude that any problems caused by these blooms, including low dissolved oxygen, will be substantially reduced by KBRA. The National Research Council (NRC 2004) report was not sanguine about the likelihood of success in improving water quality in the face of current upper basin land use and depleted hydrology.

3.4 Adult/Juvenile Movement and Migration (C-7)

Restated Question: Can adult and juvenile coho salmon readily and successfully move between habitats downstream of Iron Gate Dam during the various life stages?

Summarized Answers:

Current Conditions: Juvenile coho movements between tributaries and mainstem are impeded by high, stable summer temperatures in the mainstem and by low flows in some periods. Impediments to adult coho migrations within the mainstem and into some tributaries have not been documented downstream of Iron Gate Dam.

Proposed Action: Both positive (e.g., greater juvenile access to habitat, greater temperature variability, warmer temperature in early spring, cooler late summer and early fall temperature) and negative effects (e.g., higher early summer temperatures) associated with the action prevent the Panel from determining the net beneficial effects. The Proposed Action alternative will create more opportunities for successful movement among habitats downstream of Iron Gate Dam than expected under the Current Conditions alternative, but how these opportunities are utilized and how the multiple effects on juveniles and adults combine into an overall response is difficult to assess.

Discussion:

Adult Coho Salmon

Adult coho salmon enter the Klamath River from approximately September to mid-December with peak upstream migration occurring between late October and mid-November (Stillwater 2010). Spawning generally occurs within a few weeks of arrival at the spawning grounds. The mainstem Klamath River is used primarily as a migratory pathway by adult coho salmon to tributary spawning areas. During 2001-2004, approximately 50 percent of all natural spawning coho salmon occurred upstream of the Trinity River and only about 5 percent of the total spawned in the Klamath mainstem (Comments on the draft report 2011; Ackerman et al. 2006). The number of natural-origin versus hatchery coho spawners is not accurately documented each year, although it is recognized that many spawners are of hatchery origin, especially in some areas such as the Trinity River. Indirect estimates indicate that 90 percent of adult coho salmon in the Klamath River system return directly to hatcheries or spawning grounds in the immediate vicinity of hatcheries (Brown et al. 1994 in Stillwater Sciences 2010). These data suggest a relatively small portion of natural spawning coho salmon occurs in the mainstem, therefore only a small proportion of total spawners and embryos would be directly influenced by dam removal under the Proposed Action.

Stillwater Sciences (2010) suggested that the following factors may currently affect survival of migrating adult coho salmon in the mainstem Klamath River: 1) high water temperature resulting from reduced flows and poor water quality (e.g., low oxygen) can stress adult fish, delay migration, reduce availability of cold water refugia, and promote infection and transmission of disease, and (2) low flows may cause passage obstructions at tributary confluences, although no evidence of blockages was provided. With regard to temperature, in 2002, average daily water temperature near Iron Gate Dam was 20°C in early September when coho began to enter the river, falling to 15°C at the beginning of the peak migration period in late October, and to less than 10°C by the end of the peak migration period in mid-November (FERC 2007 in Hamilton et al. 2010). No quantitative estimates or approximations were provided for coho pre-spawning mortality, but Hetrick et al. (2009) reported significant pre-spawning mortality of Chinook salmon during October (average of approximately 50 percent, with a range of 0 to 100 percent) when many coho also enter the watershed. No quantitative estimates were provided for blockage of adult coho migration into tributaries resulting from obstructions at tributary mouths when mainstem flow is low.

Although Stillwater Sciences (2010) suggested mainstem flows following dam removal will be greater during the adult coho migration period, simulation modeling for 2012 to 2061 indicated that flows would be lower during October through December (Figure 4 above; B. Greimann PPT Presentation 12/13/2010). Therefore, potentially lower flows during the fall under the Proposed Action alternative may reduce the ability of coho to migrate through the mainstem in order to reach spawning areas in tributaries; however, field studies indicate flows within tributaries are more important to passage than mainstem flows (Sutton 2007). Actions proposed under the KBRA in the tributaries are intended to provide greater accessibility to spawning habitats in tributaries, through manual alteration of tributary confluence channels (Stillwater 2010; KBRA Action Item ID#2) and increased stream flows through purchasing of water rights (KBRA Action Item ID#8). KBRA actions may increase flows in tributaries and alteration of the tributary mouth morphology, but it is not possible to fully evaluate the effectiveness of these potential actions at this time because the degree to which these factors currently reduce reproductive success of coho salmon is unknown.

After dam removal, it is expected on the basis of simulations that water temperature during adult coho migration at Iron Gate Dam will be approximately 2-8°C cooler than at present (see Figure 8 in Hamilton et al. 2010, Dunsmoor and Huntington 2006). Water temperature at the beginning of the coho migration period (September) can be stressful (~20°C), and Hetrick et al. (2009) reported high pre-spawning mortality of Chinook salmon in October. However, pre-spawning mortality has not been quantified for coho salmon in the Klamath River, and it is difficult to extrapolate pre-spawning mortality of mainstem spawning Chinook to that of coho salmon. Although coho begin entering the Klamath River in September when upstream temperatures are high, coho appear to hold in lower river areas while waiting for cooler temperatures and higher flows (Ackerman et al. 2006). Therefore, cooler water as a result of the Proposed Action alternative might help alleviate stress or thermal mortality of coho salmon and might enable earlier upstream migration, but it is not possible to estimate to what extent cooler water may enhance migration and spawning success of coho salmon.

Juvenile Coho Salmon

The large majority of juvenile coho salmon rear in tributaries rather than in mainstem habitats during summer, largely because mainstem temperatures become too warm for coho salmon (e.g., greater than 20°C in July and August) (Hamilton et al. 2010; Stillwater 2010). For example, only 3 percent of pools surveyed in the mainstem (location not reported) were occupied by juvenile coho salmon, compared with 41 percent by juvenile Chinook and 88 percent by juvenile steelhead. In the large, relatively warm tributaries (e.g., Shasta River) and in the mainstem, juvenile coho salmon occupy thermal refugia during periods of relatively high temperature stress (Chesney, PPT Presentation 12/13/2010; see Section 3.7).

Lestelle (2010; PPT Presentation 12/13/2010) presented a conceptual model of seasonal habitat use and movement patterns by juvenile coho salmon in the Klamath Basin, based on research in the Klamath Basin and other regions. The working hypothesis is described here. Fry in natal tributaries may disperse downstream in the spring, often during the period of receding spring runoff. Fish that disperse to the mainstem Klamath River find residence along the river margin or in adjacent slow velocity habitats within the river corridor. As water temperatures increase, juveniles within mainstem habitats of the Klamath River initiate another movement in search of thermal refuge, primarily cool water refugia in lower tributaries connected to the mainstem (see Section 3.7; Sutton et al. 2002; Deas and Tanaka 2006; Sutton 2009; Hillemeier et al. 2009 in Lestelle 2010). Juvenile coho salmon remain in these thermal refugia during summer when mainstem temperatures are stressful, but they may move back into the mainstem to feed when water cools at night, as has been documented in other watersheds. However, some tributary refugia may not connect with the mainstem during summer and fall until flow increases. As temperature declines in September, most juvenile coho generally remain associated with local areas if conditions are suitable, or disperse if food availability or densities are unfavorable. Some evidence in other watersheds and unpublished data in the Klamath River suggest that juvenile coho along the margins of large rivers tend to grow faster than those in small tributaries (Lestelle 2010, Yurok Tribe comments on the draft report). In fall, when flows increase, some juvenile coho in the Klamath basin move to find habitat suitable for overwintering (e.g., ponds), as documented in the Pacific Northwest. This behavior is apparent for juveniles found in relatively steep tributaries in the mid-Klamath region in early fall prior to increased flows. Passive Integrated Tag (PIT) tagging of juvenile coho in the mid-Klamath region during summer and fall, together with fyke net trapping at numerous sites within the mainstem corridor and stationary PIT tag detectors, show a significant redistribution of coho over the winter. The extent of redistribution has tended to be less for fish residing in the mainstem corridor upstream of Happy Camp (RM 110), where mainstem and tributary flow variation is generally small. Significant overwintering habitat includes ponded water areas, especially those areas in the lower watershed. Growth of coho in these ponds appears to be substantial. The migration of coho smolts primarily occurs during April and May, although some fish emigrate in March and June.

Evidence suggests that high and stable water temperature in the mainstem is a key factor limiting movement and dispersal of juvenile coho salmon during the summer. Mainstem water temperature near Iron Gate Dam during the Proposed Action alternative is predicted to be about 2-4°C warmer during February to mid-July and about 2-8°C cooler from mid-July to January, and diurnal fluctuations would also be much greater with dam removal (see Section 3.2). Greater variability in diurnal water temperatures and in response to weather patterns may facilitate greater movement of coho salmon between refuge areas. This would benefit coho salmon under the Proposed Action alternative.

In spring, elevated water levels (mainstem and tributaries) likely enable movement of fry and yearlings (pre-smolts) to and from the mainstem and tributaries under either alternative, but the Proposed Action alternative would enable access to warmer mainstem water in spring than is currently available. Warmer mainstem water in spring during the Proposed Action alternative might provide greater growth potential for coho compared with the cooler mainstem water expected under Current Conditions. Growth potential of mainstem margin habitats may be greater than that of tributaries (Cederholm and Scarlett 1982 in Lestelle 2010, Yurok Tribe comments on the draft report). The size of natural coho smolts in the Klamath River is large (avg. ~130-141 mm; data provided by Yurok Tribe comments on draft Panel report). Under the Proposed Action alternative, coho would still need to leave the mainstem areas when water temperature reached stressful levels, which might occur earlier than under the Current Conditions alternative (see Section 3.2). During fall, mainstem temperatures would cool off earlier under the Proposed Action alternative, and allow earlier and potentially longer access to mainstem habitats and to potential overwintering areas. The cooler water with the dams out may reduce stress during early fall but slightly reduce growth potential of fish residing there during late fall.

Coho smolts primarily emigrate from the Klamath River during April and May. Experimental PIT tag releases of coho salmon from Iron Gate Hatchery demonstrate that these fish undergo high mortality from the hatchery to RM 20 (35 percent, 50 percent, 46 percent in 2006, 2007, 2008, respectively), and most mortality occurred upstream of Scott River (Beeman et al. 2009). Greater growth potential associated with increased mainstem water temperature in spring might provide a small benefit for emigrating coho smolts under the Proposed Action alternative, except for late-migrating fish that may encounter high water temperatures that will occur earlier under this alternative. Bioenergetic modeling could evaluate this effect of water temperature on coho salmon. These fish may also be more susceptible to pathogens (Section 3.10). Monthly flows in the Klamath River are not expected to change markedly during the spring smolt outmigration period (see Figure 4 above; Greimann PPT Presentation 12/13/12010), although Hetrick et al. (2009) suggested there may be higher spring peak flows after dam removal that would benefit outmigrating smolts.

3.5 Tributary versus Mainstem Spawning (C-8)

Restated Question: Which alternative offers the greatest opportunity to increase spawning habitat of coho salmon in the mainstem and tributaries downstream of Iron Gate Dam? (see Section 3.6 for habitat opportunities upstream of Iron Gate Dam)

Summarized Answers:

Current Conditions: Spawning habitat capacity and quality, and spawner abundances have not been consistently documented for coho, but nearly all spawning occurs in tributaries. Present conditions appear to be degraded for coho based on their population status.

Proposed Action: The Proposed Action may increase and improve spawning habitat for coho, but the benefits will depend on the combined effects of changes in flow and temperature due to removal of the dams and the effectiveness of unspecified KBRA activities targeting spawning habitat in tributaries. The area of mainstem spawning gravel downstream of Keno Dam will increase but its quality will be diminished by sand content for at least the first few years. Fall flows in the mainstem will be lower and may influence coho spawning migrations to tributaries.

Discussion:

During 2001-2004, approximately 50 percent of all natural spawning coho salmon occurred upstream of the Trinity River, almost entirely in tributaries (Comments on the draft report 2011; Ackerman et al. 2006) The number of natural origin coho spawning in tributaries versus mainstem habitats is not documented each year, although it is recognized that many spawners are of hatchery origin. Indirect estimates indicate that 90 percent of adult coho salmon in the Klamath River system return directly to hatcheries or spawning grounds in the immediate vicinity of hatcheries (Brown et al. 1994 in Stillwater 2010). Although little spawning occurs in the mainstem where dam removal would have its greatest effect, juveniles produced in upstream tributaries would have access to mainstem rearing and migration reaches when conditions were suitable.

Significant efforts (in terms of monetary expenditures) would be made to improve conditions in the Klamath Basin downstream of Iron Gate Dam under each alternative (Table 2; Stillwater 2010), but the level of effort would be considerably greater under the Proposed Action alternative (Table 5). Most of the effort would occur in tributaries where nearly all coho spawn. However, at this early stage of planning, the linkage of the specific habitat restoration activities with predicted effects on targeted species (e.g., coho), life history stage, and process (e.g., migration, spawning, rearing, foraging) has not been completed. Some of these projects have the potential to benefit spawning coho salmon (e.g., fish passage, treating sediment sources, setting minimum flows, cattle exclusion, gravel augmentation), but it is impossible to estimate the effects these actions might have on spawning coho salmon with the information available. There has not been an assessment to determine whether coho spawning habitat quantity and quality is limiting reproductive success and, ultimately, the overall abundance of coho salmon. However, the Yurok Tribe believes coho spawning habitat is not a factor controlling productivity and abundance of coho salmon (Yurok Tribe comments on the draft report 2011). The extent to which these actions might "fix" habitat problems is unknown. For example, what percentage of stream banks that are influenced by cattle would be fenced? What percentage of riparian habitat would be influenced by the proposed actions? It is critical that habitat restoration activities target species and life history stages, that forecasts of likely effects be made, and that monitoring be used to evaluate projects and to make corrections as needed.

Very small numbers of coho salmon apparently spawn in the mainstem. Flows during the coho spawning period in fall are expected to be somewhat less following dam removal (see Figure 7 in Hamilton et al. 2010; Figure 4 in this report). However, cooler temperatures during fall under the Proposed Action alternative might benefit those few coho that spawn in the mainstem, if they experience pre-spawning mortality in relation to moderately high temperatures, as do Chinook salmon during October (Hetrick 2009; average of about 50 percent mortality among sample periods). The Proposed Action alternative may lead to slightly better spawning habitat for those few fish that spawn in the river (through gravel augmentation and re-establishment of natural gravel supply from the impounded reach); however, we received no information on numbers or percentage of natural-origin coho that spawn in areas downstream of Iron Gate Dam.

Table 5. Magnitude of Anticipated Habitat Restoration Activities Downstream of Iron Gate Dam (excluding Trinity River Basin) Under Each Alternative (The monetary expenditures of the current conditions and dams-out alternatives would be approximately $100.9 million and $242.5 million during 2012-2020, respectively).

Restoration Action	Current Conditions	Conditions without Dams and with KBRA
Mainstem Klamath River		
Floodplain Rehabilitation (miles of channel)	0.8	2.0
Large Woody Debris (miles of channel)	10	63
Cattle Exclusion (miles of river)	122	146
Conservation Easements/Land Purchases (acres)	0	1176
Gravel Augmentation Downstream of Iron Gate Dam	Yes	Until dams removed
Klamath River Tributaries		
Floodplain Rehabilitation (miles of channel)	6.21	13.27
Large Woody Debris (miles of channel)	38	198
Fish Passage (number of locations	66	73
Cattle Exclusion (miles of river)	41	153
Riparian Planting (acres)	0	346
Mechanical Thinning to Promote Conifers (acres)	200	7,945
Fire Treatment (acres)	45,000	116,050
Conservation Easements/Land Purchases (acres)	10,000	21,800
Road Decommissioning (miles of road)	470	1,330
Treating Sediment Sources (projects)	100	240
Instream Flow Studies	Yes	Yes
Obtaining Minimum Flows	Possible	Likely

Source: Stillwater 2010

3.6 Access to Habitat (C-1, S-1, G-4)

Restated Question: How will increased access to habitat upstream of Iron Gate Dam benefit coho salmon and steelhead populations?

Summary Answers:

Current Conditions: Coho salmon and steelhead will not have access to habitats upstream of Iron Gate Dam.

Proposed Action: Access to habitat between Iron Gate and Keno Dams will allow for a small increase in coho and potentially larger increases in steelhead populations. If both upstream and downstream passage through Keno Reservoir and Upper Klamath Lake are successful, then access to upstream habitat (above Upper Klamath Lake) could increase the abundance of steelhead (possibly substantially) and coho salmon if fish utilize the new habitat and can successfully complete their life cycles. Increased diversity of life histories and greater spatial distributions are also possible if the new habitat is of high quality that results in fish being more successful in completing their life cycles. However, recolonization of habitats above Upper Klamath Lake are uncertain because many factors may limit population success, especially for coho salmon.

Discussion:

The Panel was provided with several qualitative and quantitative estimates of positive responses by coho salmon and steelhead populations to projected changes in both habitat quality and quantity under the Proposed Action alternative (Table 6). Population responses to habitat alterations are notoriously challenging to estimate, and honest estimates must include an evaluation of key assumptions and uncertainties. The Panel believes that the qualitative estimates of positive population responses for both coho (small because less likely to recolonize above Upper Klamath Lake) and steelhead (possibly substantial if recolonization occurs above Upper Klamath Lake) are reasonable, but information is currently insufficient for providing quantitative estimates.

Table 6. Estimated Population Responses by others (not the Panel) of Coho Salmon and Steelhead to the Proposed Action (Conditions without Dams and with KBRA).

Source	Coho	Steelhead
ODFW 2010 (Smith Memo)	Not estimated	30,000 half-pounders
Stillwater Sciences 2010	Restoration will increase the growth, survival, and abundance of coho salmon smolts	Similar to positive benefits for coho
Hamilton et al. 2010	"Likely to increase persistence"	"would enable reestablishment"
Huntington 2004	Not estimated	8,645 (mean of several estimates, upstream of Upper Klamath Lake only)

It is reasonable to hypothesize that new populations of coho and steelhead between Iron Gate Dam and Keno Dam, once established, should help 'spread the risk' in terms of long-term viability of salmon and steelhead in the face of climate change (McElhany et al. 2000). This might be particularly applicable to populations in the Upper Klamath Basin, where groundwater-dominated habitats might allow persistence in the face of habitat losses that are expected with climate change. However, the effects of predation and of competition for thermally benign habitat do not appear to have been considered in sufficient detail in the projections of the effects of extending the range of anadromous fish into the upper basin.

Increased access to habitat upstream of Iron Gate Dam could contribute to population viability of coho salmon and steelhead to the degree that fish utilizing the newly-accessible habitats can successfully complete their life cycle. For example, successful contribution of individuals from the new habitat would require that: 1) newly-accessible habitat is suitable for spawning, egg incubation, and juvenile rearing; and 2) fish in the newly-accessible habitats do not incur increased costs relative to downstream populations (e.g., decreased survival of outmigrants). Survival of emigrating steelhead smolts and coho smolts is currently low, although the data for steelhead and coho are hatchery-based and limited (Beeman et al. 2009; ODFW 2010). This raises concerns about the survival rates of smolts originating higher in the basin. Survival of wild coho salmon and steelhead will likely be higher than hatchery fish, particularly under the Proposed Action alternative.

Materials provided to the Panel included numerous examples of reasons that population responses to new habitat may be modest, at best. We have attempted to summarize key uncertainties for population response estimates below.

One uncertainty is the colonization ability and the feasibility of active re-introduction. Pess (2010) outlined factors influencing the likelihood of colonization success by salmonids. The ODFW (2010 Smith Memo) summarized the likelihood of colonization of the upper Klamath Basin by steelhead, given known characteristics of the population and habitat conditions between Iron Gate Dam and Link Dam. They concluded that the proximity of the source population, straying rate, habitat type and condition, and life history adaptation to local conditions were sufficient to make steelhead colonization highly likely. The Panel concurs with their analysis. The documentation of at least 33 distinct life history categories among steelhead in the Klamath Basin (Hodge 2010) provides further evidence that a high degree of life history plasticity is present, and may contribute to the likelihood of re-emergence of anadromy in the upper basin.

The ODFW has not addressed the likelihood of colonization by coho salmon. Colonization by coho appears less likely than by steelhead but still possible, particularly if conditions affecting the survival and abundance of downriver populations improve substantially (ODFW 2008). Greater abundance of coho in downstream areas would increase the likelihood of some coho straying upstream to colonize tributaries such as Spencer Creek.

A second major uncertainty is the survival and productivity of the fish in newly colonized habitats. Colonizing or reintroduced steelhead will have access to small areas of high-quality habitats for spawning and early juvenile rearing in the mainstem Klamath River and in tributaries upstream of Iron Gate Dam, including Upper Klamath Lake and its tributaries (Carter and Kirk 2008). The mainstem Klamath River supports steelhead rearing and resident *O. mykiss*, even below Iron Gate Dam; up to 1,000 fish per mile (Carter and Kirk 2008). Coho salmon may have been historically present at least to Spencer Creek (Hamilton et al. 2005), and re-introduction scenarios extend coho salmon upstream to that point. Habitat suitability estimates and surveys provided by Huntington et al. (2006), Fortune et al. (1966), and others provide useful information on the distribution of suitable habitat for steelhead and coho salmon upstream of Iron Gate Dam. In questions to the Panel, these habitats have been described as "unused" but they are in fact occupied by a variety of native and non-native fish species. The success and productivity of steelhead and coho salmon in the newly-accessible habitats will depend on the following factors:

1. The extent of competition and predation experienced by colonizing steelhead, particularly the partitioning of resources between steelhead and non-anadromous *O. mykiss* (Huntington et al. 2004, ODFW 2010). Steelhead may be at a disadvantage relative to resident trout when smolt emigration and marine survival rates are low.
2. Migratory survival of steelhead adults and juveniles through the Link Dam to Keno Dam reaches where poor water quality may create seasonal barriers to successful movement (ODFW 2010).
3. Productive capacity and adaptive fitness of coho salmon in the newly-accessible habitat. Lestelle (2006) hypothesized that an interior-form coho salmon, if still present, would likely be more successful in migrating to and from the upper basin.

Near-term research could clarify life history information for resident *O. mykiss* in Upper Klamath Lake and tributaries, to provide baseline information that could help assess the likelihood of emergent anadromous life histories, and to identify the degree of potential resource partitioning between resident *O. mykiss* and anadromous forms. Studies could document evidence for and source of outmigrants observed downstream of Link Dam. Post-colonization studies could establish the degree and type of interaction between resident *O. mykiss* and steelhead in new habitats, as described in ODFW (2008).

Given the seasonally poor water quality in Keno Reservoir, it would seem prudent to test opportunities for water quality improvements, or at least to assess the success of fish at two-way passage through experimental trap-and-haul releases in Keno Reservoir, before assuming that anadromous fish will complete these stages of their life cycle. The Panel was provided with summaries of proposed KBRA activities, including water quality treatment and management for the Keno Reservoir, but details on the expected success of these activities were not provided. The Panel notes that the TMDL for the Lost River and Link River, which discharge into Keno Reservoir, is set for warm-water fishes not cold-water species such as coho salmon and steelhead. Additionally, the National Research Council (NRC 2004) report suggested water quality problems were unlikely to be overcome.

If water quality and passage issues cannot be addressed, pilot studies should assess risks and feasibility of the trap-and-haul alternative that has been proposed, building upon experiences gained from other reintroduction programs (e.g., Cowlitz and Toutle River, WA) and perhaps using large migratory *O. mykiss* as a proxy for steelhead.

3.7 Refugia (C-2, S-2)

Restated Question: How will the two alternatives differ in the effects of thermal refugia on productivity, capacity, and habitat connectivity for steelhead and coho?

Summarized Answers:

Current Conditions: With present conditions, thermally-suitable summer rearing habitats for coho salmon and steelhead will be primarily restricted to colder tributaries and isolated refugia downstream of Iron Gate Dam.

Proposed Action: Maintenance and restoration of groundwater-dominated habitats accessible to coho and steelhead under the Proposed Action will likely increase availability of thermal refugia over Current Conditions. However, the extent to which any increased thermal refugia will benefit the productivity of coho and steelhead is not known. The Proposed Action should facilitate persistence of both species more than continuation of Current Conditions, especially in the face of habitat losses that are expected under climate change.

Discussion

With Current Conditions, thermally-suitable summer rearing habitats for coho salmon and steelhead are primarily restricted to cold tributary confluence refuges in the mainstem (e.g., Sutton et al. 2007), groundwater-fed habitats in tributaries (e.g., Big Spring Creek tributary to Shasta River; Chesney PPT Presentation 12/13/2010), and colder portions of tributary habitats. Warming and shrinkage of cold-water habitats within tributaries due to water withdrawals and diversions, land use, and riparian alteration have increased reliance of coho salmon and steelhead on the remaining remnant, and often fragmented, cold-water habitats. Coldwater habitats upstream of Iron Gate Dam are not currently available to anadromous salmonids. In tributaries downstream of Iron Gate Dam, ongoing restoration efforts, including riparian vegetation protection and enhancement, water management to increase summer streamflows, and re-connection of isolated cold-water habitats in the tributaries, could increase the availability of thermally suitable habitats for coho salmon and steelhead. Enhancement of tributary confluence refuges through placement of large wood, improved access, or additions of other types of cover could enhance the capacity of these refuges. Improvements to summer rearing capacity and habitat quality associated with these activities have the potential to improve pre-smolt production in the basin, particularly where limiting-factors analysis indicates that summer habitat capacity is temperature limited.

Under the Proposed Action alternative, newly established populations of coho salmon and steelhead upstream of Iron Gate Dam should help spread the risk in the long-term viability of salmon and steelhead in the face of the continuing stresses from land and water resource use in the upper basin and climate change. This might be particularly applicable to populations in the upper Klamath basin, where groundwater-dominated refuges might allow persistence in thermally suitable habitats in spite of expected warming. These benefits will be greatest for steelhead, assuming they are able to successfully colonize the spring-fed stream systems upstream of Upper Klamath Lake. Benefits for coho salmon will depend on the success of establishing productive coho salmon populations in these colder upper-basin habitats. The highest probability of success will be within the known historical range of coho salmon where cold-water habitats can be rehabilitated or maintained, such as the lower reach of Spencer Creek. Establishment of coho salmon above Upper Klamath Lake is much less certain, but if attained, would be a significant contribution to the spatial diversity and suite of life history options available to Klamath Basin coho populations (Lestelle 2006). Restoration of streamflows in tributaries downstream of Iron Gate Dam (e.g., Shasta and Scott Rivers) will likely be essential for enabling coho salmon populations to respond to habitat improvements there, providing a potential source of colonists for the new habitats above Iron Gate Dam.

Thermal refuges can occur at several spatial scales. While most references to refuges pertain to features at the scale of habitat units [1-10 square-meters (m^2); e.g., Klamath mainstem-tributary pool refuges], thermal refuges can occur at reach scales (Big Springs complex in the JC Boyle Bypass reach) or catchment scales [1-10 kilometers (km); Spring Creek, Williamson River tributary, springs within Upper Klamath Lake]. Small refuges can be critical for allowing fish to persist in stream reaches where they might otherwise perish, but such refuges can be ephemeral in the face of changing stream flows, and can result in high concentrations of fish that lead to increased exposure and susceptibility to disease or predation. As a result, the population-level importance of these features is highly dependent upon their capacity, and the net survival benefits conferred to fish that use them. Larger thermal refuge features can be more stable and predictable, and possess much higher capacity. Reach-scale or catchment-scale thermal refugia can also provide a suite of resources for fish, by containing a diversity of habitats that may support multiple life-history stages. These larger-scale refugia will provide the most significant benefits to steelhead and coho salmon, from a perspective of population persistence.

Estimating the contribution of cold-water refuges to fish populations requires an understanding of the following factors, which may vary in importance with spatial scale:

1. Thermal regime of the refuge and the ambient conditions, including the length of time fish need these refuges (Sutton et al. 2007).
2. Bioenergetics of trade-offs between benefits of thermal refuge use and costs associated with reduced foraging opportunities or increased risk of predation, disease, or mortality from disease (e.g., Coutant 1987).
3. Capacity of the refuge (e.g., Armstrong 2001).
4. Accessibility of the refuge, including proximity to corridor habitats, and frequency and spacing of refuges that could allow movements of fish through thermally stressful river

corridors, including both long-range movements and potentially diurnal movements to and from foraging and refuge habitat.

5. Relative importance of refuge availability, given above conditions, in the overall life cycle and productivity of coho salmon and steelhead populations. This may vary with population size because of the presumably limited capacity of the refuges.

Information on potential cold-water sources available in and upstream of the Project Reach suggests that several areas are highly likely to provide high-quality refuge habitats. The Big Springs complex in the J.C. Boyle Bypass reach has a well-documented thermal regime and flow, providing excellent water quality year-round (USDI Bureau of Land Management 2003). Bartholow and Heasley (2005) provide an approach for predicting temperatures under different flow regimes by month that is useful for projecting thermal conditions under future flow scenarios. The mainstem river channel in this location (Big Springs) is relatively high-gradient, with boulder substrate and relatively high water velocities, but with some backwater habitats and off-channel areas. Current densities of *O. mykiss* are locally high in this reach (Carter and Kirk 2008). As such, the Big Springs complex is likely to provide high-capacity, high-quality rearing habitat for juvenile steelhead rearing, and could complement the potential spawning and rearing habitats in Spencer Creek upstream. Adult summer-run steelhead, if present during periods of thermal stress, could also utilize this refuge, but the capacity of this habitat for adults and associated risks associated with harassment and poaching would need to be assessed. Currently, Klamath summer-run steelhead enter the river in March through June (Hopelain 1998 cited in Stillwater 2010), and primarily enter cold tributaries to estivate. If summer steelhead are to utilize thermal refuge habitats in the Project Reach and upstream, they will need to enter the Klamath River sufficiently early to be able to access these reaches before the intervening mainstem temperatures inhibit migration. Fall/winter steelhead, which arrive at Iron Gate Hatchery October during the winter (Shaw et al. 1997), could presumably access the Project Reach after adverse thermal and DO conditions become more favorable in late fall.

There is much less suitable rearing habitat for other anadromous species (such as coho salmon) at Big Springs because of high flow velocities in the channel and the limited amount of off-channel, lower-velocity habitats (Huntington and Espinosa 2006). Fall migrating coho salmon are unlikely to require thermal refuge habitats in the Project Reach. Coho salmon juveniles would be more likely to utilize cooler waters in small tributaries and Spencer Creek.

Increasing water temperatures and decreasing flows in the tributaries in spring can lead to mass emigration of young-of-the-year coho salmon from tributaries into the Klamath River mainstem (Chesney and Yokel 2003). Downstream emigration of fry in the spring is a common life-history pattern in coho salmon populations, but its contribution to populations depends on the ability of these fry to find suitable habitats (Koski 2009). In the Klamath Basin, emigration of fry from tributaries to the mainstem may be a costly tactic for coho salmon, because the likelihood of survival under Current Conditions in the mainstem is low unless fish find suitable refugia (NRC 2004). Remaining in tributaries subject to water withdrawals or high summer water temperatures is also perilous for coho salmon fry. The paucity of favorable rearing options for coho salmon juveniles in these reaches highlights the need for integrated improvements in both mainstem and tributary habitats, including restoration of tributary flows.

Significant benefits to productivity of coho salmon in tributaries could be realized in several ways by the KBRA. If water temperatures could be reduced by substantially increasing the extent of riparian vegetation, and summer stream flows increased substantially through improved flow management, summer carrying capacity of tributary habitats might be increased. This should reduce some of the losses of fry to hostile habitats. Improvements in summer rearing conditions in the mainstem and enhancement of known refugia could allow increased survival of out-migrating fry and juveniles that utilize the mainstem during summer, and allow greater expression of a life-history type that is currently suppressed (Lestelle 2006). However, the extent of any such improvements is unclear from the description of KBRA provided to the Panel, so the magnitude of improvements in survival cannot be estimated. But perhaps most importantly, restoration of thermal regimes through water management and riparian improvements could, if successful, reduce the need for thermal refugia, expanding summer spatial ranges and options for rearing and migration (Dunsmoor and Huntington 2006).

3.8 Habitat Restoration (S-7)

Restated Question: How will the two alternatives differ in the effects on productivity, capacity, and habitat connectivity for steelhead?

Summarized Answers:

Current Conditions: This alternative could result in small improvements in habitat for steelhead due to TMDLs, the NMFS coho BO, and ongoing non-KBRA restoration activities. However, these actions are not necessarily targeted for steelhead and, without specific targeting for steelhead, their effectiveness for steelhead is likely to be low.

Proposed Action: Improved habitat conditions over that with Current Conditions are likely for steelhead, including increased capacity and connectivity, but the net effects on abundance are unknown. Passage through Keno Reservoir and Upper Klamath Lake could continue to be a problem, depending on the success and effectiveness of the KBRA. The potential for significant increase in habitat for steelhead is present under the Proposed Action, but it is difficult to estimate the degree to which this potential is likely to be realized.

Discussion:

The Panel can only state that if the KBRA is implemented effectively, improved habitat conditions are likely for steelhead. Under the Proposed Action alternative, steelhead would have access to substantial habitat that is currently inaccessible upstream of Iron Gate Dam, and KBRA will improve habitat throughout the system. The Current Conditions alternative will likely result in, at best, relatively small improvements in habitat for steelhead (TMDLs, NMFS coho BO, etc.) because these actions are not necessarily targeted for steelhead and thus steelhead would continue at the historical low levels or decline further.

The Panel was unable to quantify steelhead population responses to KBRA actions because we were given no quantitative information of the nature and extent and location of proposed KBRA actions, presumably because planning and design of these investments have not evolved beyond the qualitative, conceptual stage. The Panel recognizes that there is potential for improved conditions for steelhead based on the following logic:

1. Steelhead are good swimmers, may stray to non-natal habitats, are more tolerant of high-temperatures than are salmon, and they are more resistant to disease than salmon.
2. Summer steelhead are found in the Klamath River up to Empire Creek and winter steelhead are found above there to Iron Gate Dam (Figures 2 and 3 in Stillwater 2010).
3. Resident *O. mykiss*, which are very similar genetically to steelhead (Currens et al. 2009), appear to be abundant upstream of the Iron Gate Dam (Carter and Kirk 2008) implying that steelhead could use at least some of that habitat.
4. Steelhead are exposed to adverse summer conditions in the mainstem for a relatively short time.
5. Some of the KBRA actions could increase spawning and juvenile rearing habitat quality.

Stillwater Sciences (2010, Appendix) repeatedly suggest that KBRA actions will result in less sediment, more low-velocity habitats, deeper pools, and cooler water from large woody debris and shading that will benefit winter and summer habitat for steelhead once they gain access above Iron Gate Dam. As stated in Stillwater (2010), the idea is to increase the number of steelhead that reside in fresh water for over 2 years because older, and therefore presumably larger, smolts provide higher returns as adults.

While logic suggests that KBRA will improve conditions for steelhead, other factors could dampen or eliminate these benefits, and uncertainty is high because the KBRA plan is so unspecific. The KBRA will not affect summer temperatures much in the mainstem, and given a higher daily mean and larger within-day fluctuations in temperatures during the summer under the Proposed Action alternative (Section 3.2), juvenile steelhead in the Project Reach will need to find thermal refugia, and those passing through could be thermally stressed. Although locally adapted interior *O. mykiss* (upper Klamath stocks) are thought to have higher thermal tolerances than coastal *O. mykiss* (e.g., Huff 2005; Rodnick et al. 2004), temperatures are predicted to exceed 19-20^{o}C, which is roughly the upper limit for growth of juvenile steelhead (Richter and Kolmes 2005). Whether the transit time will be short enough, or there will be sufficient thermal refugia to ameliorate the thermal stress, is unclear.

Poor water quality in Keno Reservoir and in Upper Klamath Lake, and the possibility of difficult passage at Keno Dam, could prevent steelhead from reaching improved habitat upstream of the Project Reach. Furthermore, the predation pressure in Upper Klamath Lake is unknown. Finally, the success of the habitat rehabilitation can be affected by how the steelhead interact and mix with hatchery and residualized steelhead in the Iron Gate region, and with *O. mykiss* upstream of the Upper Klamath Lake. If the habitat added or improved is sufficient to affect steelhead, then will the redband also respond to the additional habitat and dampen the response of steelhead? Some evidence suggests that *O. mykiss* shows signs of migratory behavior, which would suggest they have maintained some aspects of their anadromy. How steelhead and *O. mykiss* will interact (competition for rearing and spawning space, food, and mates) and whether *O. mykiss* will produce migratory smolts, which would then be considered steelhead, are unknown. While the Panel received qualitative statements and opinions (many based on some scientific evidence) that the each of these issues was manageable, the combined effects of these issues (i.e., over the entire life cycle) are unknown. Some benefits to steelhead may be influenced by interactions with the already established *O. mykiss*, although both subspecies have co-existed in other systems.

The uncertainty with many of these issues can be reduced before and during implementation of specific KBRA actions with targeted sampling and measurements, some of which are closely aligned with ongoing studies. To address the thermal issue in the mainstem, sampling the health (e.g., condition) of individual steelhead in the mainstem during the warm period would provide information on whether the conditions are too stressful, and further consideration or expansion of the ongoing tagging studies and of other studies (e.g., Sutton et al. 2007) would determine exposure times to stressful conditions and how well fish were finding thermal refugia when needed. Assessing the success of fish passage at the dams is currently possible, and water quality monitoring of the Upper Klamath Lake can at least determine if stressful conditions exist. Dunsmoor and Huntington (2006) and Maule et al. (2007) provide a good start for such an evaluation. Predation within Keno Reservoirs and Upper Klamath Lake is very difficult to quantify, but determination of the numbers of exiting smolts from tributaries to Upper Klamath Lake, Klamath Lake itself, and Keno Reservoir is one possible way to identify any upstream bottlenecks (without knowing the cause). The predicted interactions between steelhead and other *O. mykiss* (redband) could be explored through experimentation and modeling, but it is complicated. Small pieces can be addressed before dam removal, such as whether existing *O. mykiss* populations produce migratory smolts that attempt to pass through Link Dam. *O. mykiss* have shown signs of migratory behavior in this system and other systems (FERC 2007). Some juvenile trout have been observed here (ODFW 2010), but further observations and analysis could determine the extent of the smoltification process.

The KBRA is a list of possible actions without sufficient detail to estimate quantitatively their effects on habitat, and the data and modeling needed to quantify the response of steelhead to these changes in habitat are lacking. The specific locations, implementation details, and combined effects of KBRA will be major factors in determining their effectiveness in affecting steelhead reproduction, survival, and growth. Overlain on this is the uncertainty about the differences in water quality that will be achieved between the two alternatives (Current Conditions and the Proposed Action, respectively) with the TMDL and non-point source programs. The hypothesis is that the Proposed Action will lead to improved water quality more quickly than the Current Conditions alternative, but how that may differentially affect habitat for steelhead is unknown. The potential for increase in habitat for steelhead is present under the Proposed Action, but how well this potential is realized is unclear.

3.9 Ecosystem Function (C-5, S-9, G-10)

Restated Question: How do the alternatives differ in the extent of natural ecosystem function, more specifically physical habitat and food?

Summarized Answers:

Current Conditions: The information available is insufficient to answer this question, but limitations on access to tributaries and the reduction of flows and the disruption of the natural sedimentation system, which together generate the physical habitat, will continue to place severe restrictions on the amount and quality of habitat available to coho and steelhead.

Proposed Action: The information available on the details of the KBRA is insufficient to answer this question, but compared to the Current Conditions alternative (continuation of current conditions), the Proposed Action will increase habitat, a component of ecosystem functioning, and dam removal should, by definition, help to an unknown degree with ecosystem functioning related to increased access and higher variation in flows. Information on food quantity and quality under the Proposed Action alternative cannot be estimated at this time. Opportunities exist to improve the state of knowledge on this topic.

Discussion:

"Ecosystem function" in this context can apply to two distinct aspects of the Klamath basin ecosystem. The first aspect is the set of geomorphic and hydrologic conditions that set up physical habitat for salmonid life history stages, including holding, spawning, rearing, and migration. This aspect, emphasized in the questions as posed, establishes necessary but not sufficient conditions for the persistence of salmonid populations.

A more complete definition is the set of physical, chemical, and biological conditions and processes that enable organisms to complete their life cycles. Although usually posed more broadly, we apply this definition of ecosystem function narrowly to include those attributes of the riverine and riparian ecosystems necessary to support salmonid populations, including physical habitat but also adequate food, some protection from predators, low incidence of disease, adequate water quality, non-stressful temperatures, and minimal exposure to toxins.

The path toward an answer to the series of questions posed to the Panel lies in the following restatement of the questions:

A. How will the two alternatives differ in the amount and quality of physical habitat available to coho and steelhead?

B. How will they differ in the degree to which coho and steelhead can gain access to the areas of habitat?

C. How will newly available physical habitat perform in supporting salmon populations (e.g., through providing shelter and food)?

D. What additional constraints on salmon reproduction or survival in the newly available habitat may arise through ecosystem processes, either in the newly available habitat or elsewhere in the system?

Many aspects of ecosystem function are discussed in other sections. These include geomorphology, sediment movement, temperature, water quality, disease, and habitat restoration, as well as aspects of the salmon that intersect with habitat characteristics such as movement, access to habitat, thermal refugia, and spawning (Sections 3.4, 3.6, 3.7, and 3.5).

In terms of answering restated questions A and B, earlier descriptions of the geomorphology and hydrology of channels upstream and downstream of Upper Klamath Lake illustrate that suitable habitat for anadromous fishes is inaccessible upstream of Iron Gate Dam and is severely limited between Iron Gate Dam and Shasta River. Dam removal will expand the available habitat downstream of Keno Reservoir (by opening up areas upstream of Iron Gate Dam (Section 3.6), but the amount of new spawning and rearing habitat in the mainstem from this action alone (dam removal without KBRA) will likely be small, especially for coho. Modest improvements to the form of the channel habitat (especially undercut banks and toppled riparian vegetation), to be expected from restoration of the natural sediment transport and sedimentation regime (and even an intensified form of these during the first few decades after dam removal), will likely improve shelter for juveniles passing downstream and rearing there. There will also be an extension of access to spawning and rearing habitat in the tributaries of the Project Reach. Tributaries will provide more spawning and rearing habitat in the Project Reach than the mainstem.

Restoration efforts, independent of KBRA, are currently improving habitat in tributaries downstream of Iron Gate Dam, but the extent of changes and their effect on populations or even use of the habitat are undocumented in the reports supplied to the Panel. Some of these efforts apparently began years ago; yet, increases in some species such as coho that depend on tributary habitat are not apparent.

The KBRA plans identify the intention to improve habitat for various species, including Chinook and steelhead, upstream of Upper Klamath Lake. However, very few of the proposed activities are defined clearly enough for their influence on the biotic components of ecosystem functions to be estimated. Moreover, the effectiveness of these habitat improvements for anadromous fishes will depend on the success of these fishes in accessing the tributaries through Upper Klamath Lake. A simple first step would be a chart of the time periods during which each species and run will need to access the upper basin (a good start was found in several documents, such as run timing tables Stillwater 2010), but then overlain on the current and hoped-for conditions (temperature, DO) in Upper Klamath Lake and Keno Reservoir at those times. Such an overlay would indicate, albeit qualitatively for the time being, the nature of the challenge to be overcome to allow each run access to the upper basin tributaries where the majority of KBRA funds will be invested. The agencies seem to be relying on being able to facilitate access to the upper basin with a trap-and-haul program to transfer fish into the upper basin if the fish cannot get there unaided. This also leaves open the issue of downstream passage of smolts. Reliance on trap-and-haul would not be a restoration of ecosystem function, and it would constitute an expensive, open-ended retreat from ecosystem restoration goals.

To answer restated questions C and D, we note that there was much discussion about the physical aspects of habitat and evidence presented that suggests the habitat above Upper Klamath Lake appears good for steelhead. However, there was little discussion of a principal element of ecosystem function, namely food quantity, quality, and availability. Food is an oft-neglected aspect of riverine fish production (Wipfli and Baxter 2010). The principal food sources in Klamath River tributaries are likely to be terrestrial insects, either in aquatic life stages, as drift, or falling in the water. There are likely benthic and food-related surveys available, and the Panel noted some evidence that food is abundant (e.g., large size of smolts), but the ability of the food base to support additional fish should be addressed. Fast growth of trophy-size redband suggests food is adequate at the current population levels. Yet, the potential for coho and especially steelhead to gain access to areas now occupied by *O. mykiss* and other fishes raises the potential for competition for food and space. Thus, the food aspects of ecosystem function, especially at higher fish abundances, have not been rigorously analyzed to date. In addition to the investigations suggested in other sections dealing with ecosystem function, we recommend an investigation to ensure food quantity, quality, and availability are sufficient for supporting the fish community.

3.10 Disease (C-6, S-10)

Restated Question: How will the two alternatives differ in incidence and impact of diseases in coho and steelhead?

Summarized Answers:

Current Conditions: Continued high incidence of infection of coho is expected. There is opportunity to reduce the incidence of disease but verifying this will require investigations and pilot manipulations (e.g., flow pulses).

Proposed Action: Removal of dams can result in reductions in disease incidence for coho over that expected under Current Conditions if flows under the Proposed Action are sufficient to disrupt polychaetes in the channel bed and disease is not spread with increased habitat access. The information available is insufficient to determine the net overall effects of the Proposed Action. Studies and pilot manipulations could reduce the large uncertainty surrounding this issue.

Discussion:

Two parasites on salmonids, *Ceratomyxa shasta* and *Parvicapsula minibicornis*, cause high infection rates and mortality in Klamath River salmon (e.g., Nichols et al. 2008). Most of the available information concerns *C. shasta*. Infection appears to be highest in Chinook; coho become infected somewhat more slowly; and, steelhead are parasitized but rarely impaired (Stone et al. 2006). The incidence of parasitic infection in salmonids has been high, although this seems to be a recent phenomenon (Stocking et al. 2006); early surveys showed infection by another parasite and high rates of bacterial infection (Foott et al. 1999, 2006). Infection by parasites is highest in the mainstem (although sampling of tributaries appears to have been limited), and in June 2004 mortality of sentinel rainbow trout was close to 100 percent at all stations downstream of Iron Gate Dam and less than 5 percent upstream of the dam (Stocking et al. 2006). This is consistent with the higher abundance of actinospores (the infective life stage) in the water downstream of Iron Gate Dam than above the dam (Hallett and Bartholomew 2006). Spawned Chinook carcasses, rather than spawning adults, seem to be vectors for bringing parasites upstream (Foott et al. 2010).

The life cycles of both parasites require the presence of an intermediate host, identified as the freshwater polychaete worm *Manayunkia speciosa* (Bartholomew et al. 1997, 2006). Thus, high abundance of worms is a necessary but not sufficient condition for disease incidence (Stocking et al. 2006).

Polychaetes surveyed during 2003-2005 were common throughout the mainstem river and occurred in all riverine habitats, including reservoirs where they were most abundant near the inflow (Stocking and Bartholomew 2007). Within the river, the polychaetes had a patchy distribution and were most common in sandy or algal habitats in areas protected from scouring. *M. speciosa* can filter plankton from the water or feed on surfaces (Stocking and Bartholomew 2007). The reason for its high abundance in the Klamath River may relate to relatively eutrophic conditions there and high abundance of plankton produced in Upper Klamath Lake and the reservoirs; its absence from the Trinity River was attributed to poor dispersal capability (Strange et al. 2010).

The prevalence of infection of polychaetes by *C. shasta* was low, except for slight elevation in Upper Klamath Lake and Keno Reservoir and 4 percent and 8 percent at two stations 16 and 28 km (9.9 and 17.4 km) downstream of Iron Gate Dam (Stocking and Bartholomew 2007). In the laboratory, the parasitic load of the worms and the rate of infection in fish were higher at a low water velocity [1 centimeter per second (cm s^{-1})] than at high water velocity (5 cm s^{-1}) (Bjork and Bartholomew 2009a).

Laboratory tests with highly susceptible rainbow trout showed a dose-response relationship between the number of actinospores per liter of water and the prevalence of infection (Bjork and Bartholomew 2009b). Although a single actinospore in 0.5 L of water was sufficient to infect over half of the fish, the time to death decreased with increasing numbers of actinospores.

The *C. shasta* story is complicated by the existence of multiple strains that can be distinguished genetically (Atkinson and Bartholomew 2010). Different strains appear to be specific to different host fish, which may explain differences in infection between Chinook and coho in some studies, and why Chinook used as sentinel fish were highly susceptible downstream of the dams and unaffected upstream of the dams (where they do not now occur). It is noteworthy that mortality of PIT-tagged coho salmon release from the Iron Gate Hatchery during 2006-2008 was high and most mortality occurred upstream of Scott Creek (Beeman et al. 2009) where infection rates appear to the highest (see Section 3.11).

Three potential consequences for disease prevalence in coho may arise under the Proposed Action from removal of the dams and an improvement of adult passage by Keno Dam under the KBRA. These potential consequences are reduction in the alternate host (polychaetes), reduction in infection by reducing Chinook salmon carcasses, and spreading of the disease above the dams. Steelhead are resistant to *C. shasta* and have not been reported to have high rates of disease from other pathogens. However, the Panel notes that the interaction among parasites, salmonids, and polychaetes is a system that will change in several fundamental ways upon removal of dams. The risk of unintended consequences seems high.

Reduction in the alternate host (polychaetes) would reduce the incidence of infection in salmon. The polychaetes are apparently unusually abundant in places, and have found microhabitats that shelter them from the usual range of flow velocities in the river. Removal of the dams under the Proposed Action would mobilize sand and coarser sediment over a period of years, and the abrasion resulting from movement of this sediment during floods may remove polychaetes. The degree of this removal needs to be determined experimentally or with field-based flow and sediment manipulation studies. Subsequent recolonization would likely be slow. This speculation could be tested experimentally by the introduction of gravel into a reach of the river with high polychaete abundance and monitoring before and after subsequent floods, particularly experimental floods designed to increase peak flow over that seen in recent years.

A reduction in loading of organic matter to the river might also reduce polychaete densities (see Section 3.4). We are unable to determine whether actions under KBRA under the Proposed Action will substantially reduce nutrient loading to the river, but the land use, hydrology, and geology surrounding Upper Klamath Lake will likely maintain eutrophic, and even hypereutrophic, conditions in the lake.

The second possible consequence is any reduction in infection opportunities under the Proposed Action alternative by reducing the density of salmon carcasses, particularly downstream of Iron Gate Dam. The high prevalence of infection some distance downstream of Iron Gate Dam apparently arises from infected Chinook salmon carcasses (mostly hatchery fish) concentrated downstream of the dam, which infect the polychaetes in and downstream of that area, resulting in a supply of actinospores to the entire lower river. This concept could be tested by intensive removal of carcasses in this reach followed by analysis of infection rates in polychaetes.

The third possible consequence is that dam removal under the Proposed Action can possibly spread infection upstream of the dams because removal of dams could allow range expansion of Chinook, coho, and steelhead. Although both parasites are present upstream of the dams, infection rates of polychaetes are lower than downstream of Iron Gate Dam, and the predominant strains of *C. shasta* upstream of the dams may not be the same as those below the dams. If the range expansion results in concentrations of carcasses near large populations of polychaetes, then high infection rates of salmon due to all strains of *C. shasta,* as well as *P.minibicornis,* could spread throughout the system. Furthermore, resident *O. mykiss* upstream of the dams could act as reservoirs for the disease (Bartholomew et al. 2007). Colonization of steelhead in tributaries upstream of Klamath Lake could introduce *C. Shasta* to resident *O. mykiss* if steelhead migrate to the headwaters where resident trout live. These headwater resident *O. mykiss*, which do not intermingle with adfluvial *O. mykiss*, are highly susceptible to *C. shast*a (see Resident Fish Expert Panel report). Given the available information, the risk of dam removal under the Proposed Action causing large-scale spreading of infection is low. However, the potential biological consequences if this low-risk event occurs can be severe.

3.11 Hatchery (C-9)

Restated Question: How will hatchery production affect the viability and genetic composition of natural origin coho salmon?

Summarized Answers:

Current Conditions: Continued hatchery production and high stray rates may reduce the fitness of natural origin coho salmon.

Proposed Action: If hatchery production ceases, fitness of natural origin coho populations might improve, but overall population abundance might decline if the increase in production of wild fish fails to offset the loss of hatchery production.

Discussion:

This question is specific to coho salmon, but the comments noted below are readily applicable to steelhead. The Panel assumed that hatchery production would continue at existing levels for 8 years after dam removal, and then stop. The Panel recognizes that Iron Gate Hatchery production may or may not cease 8 years after dam removal but the decision process for determining an ending date has not been described.

Approximately 0.58 million yearling coho, 0.9 million yearling steelhead, 8.5 million subyearling Chinook salmon and 2.2 million yearling Chinook salmon are released annually from Klamath Basin hatcheries (Table 7). Most coho and steelhead are released into the Trinity River whereas most Chinook salmon are released immediately downstream of Iron Gate Dam. Adult returns of these species are dominated by hatchery salmonids, and many of these hatchery fish stray to streams where they breed and almost certainly interbreed with natural-origin fish in the watershed. For example, coho salmon from Iron Gate Hatchery frequently stray into important tributaries, with hatchery fish making up an average of 16 percent of recovered carcasses in the Shasta River (Ackerman and Cramer 2006). The Panel is not aware of basin-wide estimates of stray hatchery coho and steelhead on the spawning grounds. Coho salmon in the Klamath Basin are part of the SONCC Evolutionary Significant Unit (ESU).

Hatchery coho salmon in the Klamath Basin are considered part of the ESU. The purpose of coho production at Iron Gate Hatchery is mitigation for dam and reservoir construction.

Table 7. Klamath River Basin Hatchery Production of Salmonids

	Mean Annual Number of Fish Planted by Species, 2004-2008					
	Coho		Chinook		Steelhead	
Facility	Subyearling	Yearling	Subyearling	Yearling	Subyearling	Yearling
Iron Gate	84	79,710	5,311,363	969,615	146	104,178
Trinity River	0	502,617	3,148,084	1,286,911	0	792,705
Total	**84**	**582,327**	**8,459,447**	**2,256,526**	**146**	**896,883**

Source: California Department of Fish and Game, Final EIR/EIS on Hatchery Operations (2010; Table 2-6).

A critical question is whether the Proposed Action has the potential to improve survival by a factor of three or four, which is what is necessary to support a sustainable fishery in the absence of a hatchery. For example, Table 8 shows that the adult return per spawner of coho spawning in the Shasta River is typically less than one, indicating production of natural origin coho salmon in this river is not self-sustaining. It is likely that this run is largely sustained by hatchery strays from Iron Gate (see reference above) and Trinity River hatcheries.

Table 8. Adult Return per Spawner (R/S) and Smolts per Spawner of Coho Salmon in the Shasta River (Source: Chesney et al. 2009). Return per Spawner is the number of adults return from a specific brood (parent spawning year).

Brood	Adults	Smolt yr	1+ coho smolts	Smolts per spawner	Adult return	Smolt to adult survival (%)	R/S
2001	291	2003	11,052	38	373	3.4%	1.28
2002	86	2004	1,799	21	69	3.8%	0.80
2003	187	2005	2,054	11	47	2.3%	0.25
2004	373	2006	10,833	29	255	2.4%	0.68
2005	69	2007	1,178	17	31	2.6%	0.45
2006	47	2008	208	4	6	**2.9%**	**0.13**
2007	255	2009	**5,118**	**20**	148	**2.9%**	**0.58**
2008	31	2010	**622**	**20**	18	**2.9%**	**0.58**

Bold values: Projected 1+ estimates for 2009 and 2010 were made by CDFG using the mean smolt per adult value (23.2) from 2001 through 2008. Projected adult returns in 2009 - 2011 are based on the average1+ smolt to adult survival rate for 2004 - 2008 (2.90%).

Smolts per spawner in the Shasta River would need to at least double for the population to be sustainable without supplementation from hatchery strays. Smolt-to-adult survival is very low, averaging 2.9 percent in recent years. Low survival at sea in recent years is consistent with low survival from 1974 to 1990 (Mahnken et al. 1998), suggesting that survival at sea may not improve in the near future. Only about 20 smolts on average are produced per spawner. In order to produce a sustainable harvest, smolts per spawner would need to triple or quadruple. This analysis is crude and limited to a few years and one tributary, but it highlights what is needed to produce a naturally self-sustaining coho population, in light of low smolt-to-adult survival.

Hatchery salmon production that leads to introgression with the wild spawning salmon stock can affect wild salmon by altering their genetic composition and associated phenotypic traits that influence fitness of individuals. Hatchery fish can affect genetic diversity of the natural-origin fish, can introduce adverse ecological interactions (e.g., competition, predation, disease), and can encourage over-harvesting of wild salmon that are mixed with the more numerous and productive hatchery stock. The effects of hatchery fish on disease are discussed in Section 3.10. Additionally, the presence of hatchery salmon can confound interpretation of the status of wild salmon. The issues of diversity, ecological interactions, and over-harvesting are briefly discussed below with reference to the two alternatives.

Increasing evidence indicates hatchery salmon have lower fitness in natural environments than wild fish (Araki et al. 2008). Furthermore, this fitness decline can occur very rapidly, sometimes within one or two generations. Figure 5 shows that reproductive success of hatchery salmonids spawning in the wild is typically lower than that of wild salmonids. For example, reproductive success of hatchery coho salmon was approximately 75 percent of that of wild coho salmon from the same watershed. Based on several studies (Figure 5), hatchery steelhead has exceptionally low fitness compared with wild steelhead. Some studies suggested hatchery fish did not have lower fitness compared with wild counterparts, but these tests usually involved wild populations that had interbred with hatchery fish over many generations (Araki et al. 2008).

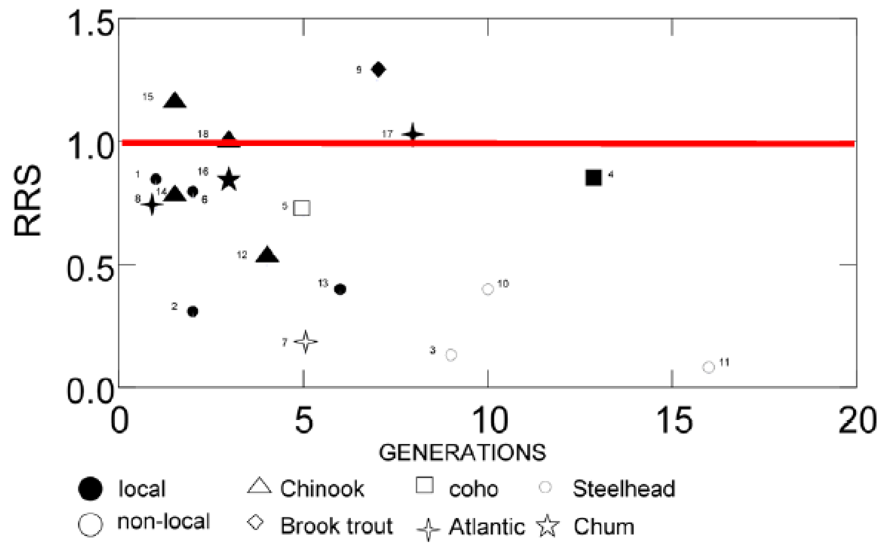

Figure 5. Relative Reproductive Success (RSS) of Hatchery (local and non-local stocks) versus Wild Salmonids in Relation to Generations of Hatchery Production (RSS is the ratio of hatchery fish fitness to wild fish fitness within the same watershed. Values below 1 indicate hatchery fish are less fit relative to wild fish in the same watershed; values exceeding 1 indicate fitness of hatchery is greater than wild fish. Note: values exceeding 1 often involve wild fish populations that have interbred with hatchery strays. Source: M. Ford, NMFS, Seattle, WA, pers. comm.; also see Araki et al. 2008).

In terms of diversity, NMFS determined that Klamath hatchery coho salmon are no more divergent from the local natural-origin population(s) than what would be expected between closely related natural-origin populations within the ESU (70 FR 37160 in Hamilton et al. 2010). This is not surprising given the level of interbreeding that occurs in the Klamath Basin. Given available information, it is possible or even likely that significant interbreeding of hatchery and natural-origin coho and steelhead in the Klamath Basin has led to lower fitness of salmonids spawning in the wild. Hatchery coho production in the Klamath Basin has been supported by coho brought in from out-of-basin hatcheries (Weitkamp et al. 1995). The level of fitness reduction among the natural origin salmonids in this system is unknown. Cessation of hatchery production in the future, as considered under the Proposed Action alternative at least for Iron Gate Hatchery, might lead eventually to greater fitness of natural origin salmonid to the extent that hatchery strays are greatly reduced (some straying is likely from the Trinity Hatchery). However, unless survival of natural origin salmonids is greatly increased in the Klamath Basin, it is possible that total adult returns (hatchery and natural origin) to the mainstem downstream of Iron Gate Dam would decline. The decline would likely be greater for coho salmon, whose abundance in the basin is more dependent on hatchery production.

Hatchery fish can introduce adverse competitive and predative interactions. A growing number of investigations indicate productivity of natural origin salmonids in freshwater and the marine environment may decline in response to large production of hatchery salmonids (Kostow and Zhou 2006; Ruggerone et al. 2010). For example, Kostow et al. (2003) and Kostow and Zhou (2006) reported that over the duration of the steelhead hatchery program on the Clackamas River, Oregon, the number of hatchery steelhead released into the upper river basin caused the total number of steelhead to exceed the carrying capacity, triggering density-dependent mechanisms that reduced reproductive success in the natural population. For the Oregon coast, Buhle et al. (2009) examined the impact of a large-scale reduction in hatchery stocking on 15 populations of wild coho salmon. Four critical factors influencing the productivity of these coho populations were identified: 1) adverse density-dependent effects of hatchery-origin spawners were five times greater than those of wild spawners; 2) the productivity of wild salmon decreased as releases of hatchery juveniles increased; 3) salmon production was positively related to an index of freshwater habitat quality; and 4) ocean conditions strongly affected productivity at large spatial scales, potentially masking more localized effects.

The Proposed Action alternative may reduce potential effects of competition to the extent hatchery production is reduced 8 years after dam removal. For example, the Recovery Implementation Science Team (RIST 2009; http://www.nwfsc.noaa.gov/trt/index.cfm) reported that reductions in hatchery coho releases on the Oregon coast led to about a 23 percent increase in the productivity of natural Oregon coast coho populations, whose abundances have been low in recent decades.

Hatchery salmonids have the potential to consume numerous wild salmon fry, but predation rates are dependent on several key factors, such as release time and location in relation to availability of salmonid prey, size of predator versus prey, and residence time of predators. For example, Naman and Sharpe (2010 PPT presentation; http://www.stateofthesalmon.org/ events/ portland_spring2010.html) estimated that 458,000 hatchery steelhead consumed 111,000 natural salmonid fry (6.4 percent of population) during a 30 day period in the Trinity River. The Conditions without Dams and with KBRA alternative has the potential to reduce predation-related mortality to the extent that hatchery fish currently consume natural-origin salmonid in the Klamath Basin and hatchery production is reduced 8 years after dam removal.

The third issue of hatchery fish potentially encouraging over-harvesting of natural-origin fish arises when natural and hatchery fish cannot be easily identified. Hatchery salmon can sustain much higher harvest rates than wild salmon simply because mortality up to the stage where the fish are released is greatly reduced in the hatchery. Wild salmon populations can be easily over-harvested in mixed stock fisheries, unless management can identify hatchery fish and maintain suitable harvest rates and escapement of wild salmon. An example of the demise of wild coho salmon following the construction of coho hatcheries is in the Columbia River (Weitkamp et al. 1995). The Panel is not aware of spawning escapement goals for natural origin coho and steelhead in the Klamath Basin. Harvests of hatchery versus wild origin coho and steelhead have not been reported to the Panel, although the Yurok Tribe stated that the harvest rate on coho is less than 10 percent (comments on the draft report 2011). The Proposed Action alternative has the potential to reduce potential over-harvesting of the natural origin stocks if hatchery production is eliminated. However, only the Iron Gate Hatchery is proposed for closure and little or no harvest occurs as a result of this hatchery production.

3.12 Expansion of Recreational Fishery (*S*-6, G-6 and 7)

Restated Question: What are the prospects for expansion of the fishery, prolonging harvest, and increasing productivity to support harvest?

Summarized Answers:

Current Conditions: Current Conditions will not, in the short to medium term, result in an expansion of the fishery. Projecting harvest under the Current Conditions depends on the fate of the hatcheries and specifics of harvest policies into the future, which are insufficiently defined at this time.

Proposed Action: The Proposed Action alternative offers a potential for more improvement in the recreational fishery for steelhead over Current Conditions. Whether this potential is realized depends on the effectiveness of the KBRA, fate of the hatcheries, and specifics of harvest policies, which are insufficiently defined at this time. Substantial improvements in the survival and abundance of ESA-listed coho salmon are needed before sport harvests on the natural component would be allowed, and this level of improvement is not likely without increased survival at sea.

Discussion:

Compared to Current Conditions, the Proposed Action alternative offers a potential for more improvement in the recreational fishery. Dam removal restores to the system river habitat that is currently under the reservoirs, provides for mainstem passage at least as far as Keno Dam, opens the possibility (but not certainty) of passage upstream of Keno Dam, opens the possibility of access to tributary habitat upstream of Iron Gate Dam, and offers the possibility of small improvements in the mainstem temperature regime downstream of the project during a window in the fall, though there is also a potential for some episodes of worse temperatures during the summer. The KBRA offers an increased budget for restoration activity (on top of ongoing restoration) downstream of Iron Gate Dam, as well as new restoration activity in the upper basin.

Given the current lack of specificity and detail of the KBRA program, and the absence of a detailed life cycle population model, coupled with the probable lack of sufficient data to simulate the genetic and behavioral consequences of hatcheries, the Panel concludes that attempts at more concrete prediction of the effects of the Current Conditions and Proposed Action on harvest is not justifiable at this time. However, the Panel notes that substantial improvements in coho survival and abundance would be necessary before directed sport harvests of this ESA-listed stock would likely occur.

3.13 Remaining Questions Not Addressed Above

In the previous sections, this report addressed the general and specific questions in its charge, except for a general question about habitat restoration (G-4), two of the four components of the Viable Salmonid Population (VSP) dealing with diversity and spatial structure, and climate change. The NMFS focuses on four population characteristics when evaluating the status and viability of salmon populations (McElhany et al. 2000). The characteristics are abundance, population growth rate (productivity over the life cycle), diversity, and spatial structure. Issues of abundance and productivity are discussed in the questions above. Diversity (G-8) and spatial structure (G-9) are discussed here. We then conclude with a discussion of climate change (C-4, S-4, G-5).

3.13.1 Habitat Restoration (KBRA) (G-4)

Restated Question: What are the likely effects of the two alternative habitat management paths on the level of harvest of fish populations?

Summarized Answers: This was discussed in the Panel's responses to the specific questions about habitat restoration (Section 3.8).

Discussion:

What distinguished this general question from the specific questions in Section 3.8 was that the stated question implied that the Panel would be provided with EDT results and the results of 2-dimensional esohabitat modeling. The Panel was not provided information on the EDT method for tributaries upstream of Upper Klamath Lake or points downstream. The 2-dimensional habitat modeling known to the Panel was presented in Hardy et al. (2006), which did not simulate the Proposed Action alternative, and was restricted to the reaches downstream of the Iron Gate Dam. Simulating this scenario would require knowing the bathymetry and other information under the no-dams conditions. Thus, this general question becomes very similar to the specific questions, which were addressed in Section 3.8.

3.13.2 Diversity of Population Structures (G-8)

Restated Questions: What will the effect of the two alternatives be on diversity of fish populations? How will the resulting diversity be manifest in the harvestable population of fish? How will potentially low baseline populations and/or introductions of hatchery fish affect diversity under the two alternatives?

Summarized Answers:

Current Conditions: Continuation of current conditions will be detrimental to the diversity structure of coho.

Proposed Action: While the KBRA has the potential to play a role in increasing diversity of coho in the Klamath by increasing population abundances and expanding available habitat, these effects are considered to likely be small by the Panel. Given the current state of the coho population, any increase in diversity, such as can occur under the Proposed Action, can be viewed as beneficial over continuation of Current Conditions. There is potential to increase the diversity of steelhead over Current Conditions, if steelhead successfully utilize the newly accessible habitat and they developed traits that are adapted to the local environments.

Discussion:

Genetic and life history diversity within and among populations has important effects on population viability (McElhany et al. 2000). Diversity in life history characteristics includes variations in adult migration timing, residence time of juveniles in freshwater (e.g., subyearlings and yearlings), distribution at sea, and age-at-maturation. Greater diversity allows a species to use a wider array of environments than they could without it. Diversity protects a species against short-term spatial and temporal changes in the environment; genetic diversity provides the raw material for surviving long-term environmental change.

Historically, the SONCC coho ESU appeared to be comprised of seven "diversity strata" as defined by NMFS, including three strata that were present in the Klamath Basin (Williams et al. 2006). In the Klamath Basin, nine distinct population units were identified: lower (mouth to Trinity River), middle (Trinity River to Portuguese Creek), upper (upstream of Portuguese Creek to Spencer Creek), Salmon, Scott, Shasta, and three populations in the Trinity. The lower Klamath population is in the Central stratum, the three Trinity populations are in the Trinity stratum, and the rest are in the Klamath stratum (Figure 1 in Williams et al. 2006). All nine populations were characterized by NMFS as functionally independent or potentially independent (Table 1 in Williams et al. 2006). NMFS concludes that there is currently insufficient data to assess the risk of the SONCC coho ESU to extinction (Williams et al. 2008), but Weitkamp et al. (1995) noted that the declines in natural coho production in these rivers in conjunction with large production of hatchery salmon suggest that the natural coho populations are not self-sustaining. The NMFS (2010) BO stated that the primary factors affecting SONCC coho diversity appear to be hatcheries, out-of-basin introductions, and abnormally low abundances in some years. NMFS (2010, P. 57) concluded, "by McElhany's (2000) criteria, this coho ESU is not currently viable in regards to the diversity VSP parameter."

While the KBRA has the potential to play a role in increasing diversity of coho in the Klamath by increasing population abundances and expanding available habitat, these effects are considered to likely be small by the Panel. Given the current state of the coho population, any increase in diversity, such as can occur under the Proposed Action, can be viewed as beneficial over continuation of Current Conditions. Reduction in hatchery strays and reduced interbreeding of hatchery and natural origin salmon, if hatchery production is reduced, has the potential for increasing diversity over time, but only if survival and abundance increase in locations throughout the basin. The Panel did not see an obvious plan or strategy to ensure that the diversity of the coho populations is enhanced or maintained by the KBRA, although reduction in hatchery production may contribute to coho diversity. Diversity of coho has the potential to increase if: (1) coho colonize habitats upstream of Iron Gate Dam after dam removal; (2) the population is viable and productive; and, (3) the colonizing fish adapt to local conditions without introgression by hatchery coho.

Klamath steelhead is part of the Klamath Mountains Province (KMP) steelhead ESU (65 FR 17845). Diversity of *O. mykiss* in the Klamath Basin is relatively high at present, as shown by the following life history characteristics: summer and winter reproductive ecotypes, "half-pounder" steelhead and variation within ecotypes, adfluvial *O. mykiss* upstream of Iron Gate Dam, fluvial *O. mykiss* in tributary headwaters, and variation in the duration (1-3 years) juvenile steelhead remain in freshwater before they migrate (NRC 2004). Genetic diversity of *O. mykiss* in the basin was described above. Diversity of steelhead has the potential to increase under the Proposed Action alternative over Current Conditions if steelhead colonize habitats upstream of Iron Gate Dam after dam removal and the colonizing fish adapt to local conditions without introgression by hatchery steelhead. Presently, hatchery returns of steelhead are low (CDFG 2010). Diversity may also increase to the extent that landlocked *O. mykiss* upstream of Iron Gate Dam successfully produce anadromous forms.

3.13.3 Population Spatial Structure (G-9)

The potential for the Proposed Action alternative to expand the spatial structure of steelhead, and less so for coho, are discussed in our responses to specific questions. Population spatial structure is related to the number and spatial distribution of spawning populations in the Klamath Basin. Spatial structure is important to population viability because it affects evolutionary processes and it may therefore alter a population's ability to respond to environmental change (McElhany et al. 2000). Additionally, a broad spawning population structure contributes to the viability of a salmon population by reducing the potential risk of catastrophic failure.

The Proposed Action alternative has the potential to increase spatial structure of steelhead and coho salmon, to the extent that viable spawning populations become established upstream of

Iron Gate Dam. Continuation of Current Conditions will be detrimental to the spatial structure of coho relative to conditions under the Proposed Action. The importance of spatial structure in the Klamath Basin is diluted to the extent that hatchery fish stray (mostly coho) and interbreed with natural origin fish, and thereby reduce the fitness of natural origin fish.

3.13.4 Climate Change (C-4, S-4, G-5)

Restated Questions: To what degree will the adverse effects of climate change be mitigated under the two project alternatives? How would access to springs in the Project Reach affect the viability of coho salmon populations?

Summarized Answers:

Current Conditions: With the possibility of less-productive ocean conditions and warming of freshwater that increases bioenergetic and disease stresses on anadromous fish, continuation of the current restoration program is unlikely to mitigate population losses.

Proposed Action: KBRA water management might ameliorate high summer temperatures in tributaries of Upper Klamath Lake. Access to springs upstream of Iron Gate Dam will increase the availability of thermal refugia. Dam removal would allow anadromous fish access to thermal refugia between Keno and Iron Gate dams. Thus, the Proposed Action will provide greater mitigation to climate change than the Current Conditions, and this mitigation should be stronger for steelhead than for coho. The degree of mitigation provided might not be sufficient to offset climate change effects that will occur within the system (e.g., loss of thermal refugia) and in the ocean, especially on coho.

Discussion:

Large springs within the Project Reach will provide thermal refugia for coho salmon that can reach the springs and compete with other likely denizens of the refugia. Outside of these springs and some large step-type pools in tributaries, the high-velocity habitats typical of the J.C. Boyle reach are not suitable for coho salmon rearing. If coho seek to utilize cold springs in the lower-gradient sections of the Project Reach, then they will have to compete with not only steelhead seeking reprieve from the heat but also some rather large *O. mykiss* trout that currently flourish in the fast-moving water of the Project Reach.

It is unlikely that either of the two alternatives will substantially mitigate the adverse effects of climate change on coho. The Current Conditions scenario already produces serious thermal stress at least in the mainstem in July-August, although few coho or steelhead are typically in the mainstem at that season because they seek cooler waters in tributaries (Stillwater 2010). Temperatures rising into the 15-20°C range may stress juvenile coho moving downstream during May-June. Under climate change, it is reasonable to expect tributaries to warm by a few degrees, but neither measurements nor model predictions were available for these critical spawning and rearing environments.

Warming of global climate, the global ocean, and within the Klamath region during the past century or more is unequivocal. Average air temperatures in the Pacific Northwest region have warmed about 1.0°C since 1900 or about 50 percent more than the global average warming over the same period (Mote 2003). Water temperature in the Klamath River has increased 0.5°C per decade in response to warming trends in the region and to anthropogenic uses of the watershed (Bartholow 2005 in Hamilton et al. 2010). The evidence for past warming and its association with anthropogenic effects is well documented and understood, generating confidence in model-based projections into the future. The warming rate of air temperatures for the Pacific Northwest over the next century is projected to be approximately 0.1- 0.6°C per decade (ISAB 2007).

Changes in precipitation have been more variable in space and not necessarily monotonic in time, but the potential for decade scale shifts in local precipitation during the past 80 years is shown by records at Keno and Tule Lake weather stations, where annual precipitation during 1927-1936 was approximately 20-26 percent less than precipitation during 2000-2009 (unpublished analysis of data by the Panel; http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?orklam). An abrupt decline in annual flows into Upper Klamath Lake (Greimann PPT Presentation 12/13/2010) occurred in 1977, corresponding with the 1976/1977 ocean regime shift coinciding with a switch in the Pacific Decadal Oscillation. There is as yet no consensus among various model predictions on whether there will be any significant change in average precipitation in the Pacific Northwest-Northern California region, although secular shifts such as the one referred to above indicate that planning must still anticipate such shifts whether or not they are driven by global warming.

The warming trend of the past century has been correlated across the northwestern United States with reductions in the proportion of snowfall to rainfall, and with earlier melting, resulting in earlier runoff and a smaller snowpack reservoir. The projected trend in declining snowpack relative to precipitation has been documented over the past 50 years by several studies across western North America (e.g., Service 2004). The result has been earlier peak stream flows in spring and lower minimum flows in summer (e.g., Leung and Wigmosta 1999).

Snow water equivalent (April 1) in the Klamath Basin has declined significantly since 1950, especially at elevations less than 6,000 ft (Mayer and Naman 2010a, 2010b in Hamilton et al. 2010). Since these melt-related changes are driven by the more securely understood and predicted warming, it is reasonable to expect a continuation of these trends over the next half-century in the absence of a clear projection of a countervailing trend in total winter precipitation. Earlier melting of snow and higher air temperatures would also expose plants, soils, and the surface of Upper Klamath Lake to longer and more intense evaporation, thereby reducing streamflow at all seasons except for winter. This climate effect on flows is expected for the small tributaries of the Klamath basin downstream of Keno Dam where runoff occurs relatively quickly from the less permeable soils on older volcanic rocks. In contrast, the Upper Klamath watershed has several geographical characteristics that will tend to buffer the effects of earlier snowmelt and increased evapotranspiration. A large fraction of the watershed is underlain by deep, permeable volcanic deposits. Fall and winter precipitation and snowmelt recharge these deep aquifers. This water is protected from evapotranspiration because much of the storage is deep underground and because the low temperatures at high elevation and thin soils with sparse vegetation keep evapotranspiration rates low during the spring and summer. Thus, the effect of climate change on peak timing of flows in the upper Klamath Basin will likely be smaller than in most hydrogeological environments of the western region. However, Tague and Grant (2008) have recently pointed out that in basins with this kind of hydrogeological condition (specifically the Montgomery River basin in Oregon) the effect of earlier snowmelt on late-summer low flows has some counter-intuitive characteristics. For a given amount of groundwater recharge, the reduction in late-August flows due to earlier melting would be smaller than in most Oregon mountain river basins in relative terms but larger in absolute terms because these local streams maintain relatively high flows in summer in response to groundwater storage.

The hydrology model predictions by Greimann (PPT Presentation 12/13/2010) for the reach downstream of Iron Gate Dam, however, do not show a decline in summer flows because it was assumed that the mandated July through September flows (NMFS BO for coho salmon) would be maintained during future climate scenarios. Likewise, during October to June, flows downstream of Iron Gate Dam were projected to be equal to or higher than without climate change because of a small increase in precipitation and intensified snowmelt under some of the climate scenarios that Greimann used for illustration of the possible range of outcomes. The predicted timing of peak flows in the Klamath River was not affected by climate change according to modeling conducted for the accepted baseline period (Griemann PPT Presentation 12/13/2010), apparently because the reservoirs, lakes, groundwater, and intentional management of flows buffer fluctuations in flows near Iron Gate Dam. For the 50-year time scale, there is no basis for confident predictions of channel-altering changes in the flood regime in response to climate scenarios.

The well understood energy balance that controls stream temperatures provides a secure basis for expecting that atmospheric warming and earlier snowmelt will translate into correspondingly higher stream and lake temperatures in the Klamath Basin. Likewise, since temperature of spring and groundwater input to rivers typically approximates the mean annual air temperature of the source area, the temperature of spring and groundwater input to rivers and streams is expected to rise correspondingly. However, deep groundwater in both the northwestern portion of the Klamath basin (and in the tectonically active Coast Range) is warm because of non-climatic (geothermal) processes associated with volcanism and tectonism. During winter low flows, this heat contributes to the stream temperature, but during periods of summertime heat stress the climatically driven radiation load and air temperature are likely to be more important. Efforts to model the effects of climate change and dam removal on stream temperatures at high resolution seem beyond current capabilities and data availability. It may be more useful to focus temperature modeling efforts on the critical times when temperature is likely to be stressful.

Thus, the effects of climate change on the stream-based portion of the life cycle of coho and steelhead will depend on whether either the upstream-swimming adult migrants or the downstream-migrating juveniles are in the main channel when temperatures are near critical levels. Temperature in tributaries will also be higher, but there are spring-based thermal refugia and shade in these environments to buffer the changes somewhat. Determining fish access to these thermal refugia in tributaries and the mainstem will be important to ensure they are sufficient to provide adequate thermal shelter. There appears to be little prospect of changes in water-supply augmentation through KBRA being sufficient to mitigate temperature increases driven by global warming. The specifics of the 30,000 acre feet of water proposed to be available under KBRA are unclear.

Climate change also affects anadromous fish species by its influence on the productivity of the ocean and marine phase growth and survival of the adult fish. Fish production in northern California and Oregon is influenced by the California Current and associated upwelling dynamics. The California Current flows southward from southern British Columbia to southern Baja California, Mexico. Upwelling of deep, cold, nutrient-rich water in the California Current is caused by northerly winds driving surface water offshore, which is then replaced by nutrient-rich deep water. Greater upwelling generally leads to greater zooplankton production, and greater growth and survival of salmon in the region (Scheurell et al. 2005; Wells et al. 2008). Inter-annual and inter-decadal trends in climate in the Pacific Northwest, including oceanographic characteristics, are partially associated with broad-scale climate patterns such as the tropical Pacific El Niño Southern Oscillation (ENSO) and the extra-tropical PDO. The warm-phase of the PDO is often associated with reduced upwelling and reduced salmon production, further modified by site-specific factors. Although climate change is predicted to produce greater upwelling in the region, the timing of upwelling may be later and less suited to the entry timing of salmon smolts into the ocean (ISAB 2007).

Climate shifts will undoubtedly influence productivity and abundance of steelhead and coho salmon returning to the Klamath Basin. Smolt to adult survival of Klamath coho salmon is already very low (~2 percent, albeit based on hatchery fish) compared with that in most northern areas, and recent data from the Shasta River indicate return per spawner of coho salmon is less than one, i.e., population declining (see Table 8 in Section 3.12; Mahnken et al. 1998). Weitkamp et al. (1995) suggested that natural origin coho production in the SONCC ESU may not be currently sustainable. Further reduction in survival at sea in response to climate shifts has the potential to offset potential improvements in the freshwater environment, or it could cause further reductions or even extinction of natural origin coho populations that are presently threatened with extinction. In light of the large effect of ocean conditions on salmon production, monitoring of juvenile production from freshwater habitats will be necessary to evaluate the effectiveness of salmon habitat projects in the Klamath Basin.

4.0 Caveats and Looking Forward

4.1 Life Cycles

The original questions posed to the Panel generally included two elements. The first element had to do with a class of issues that may be addressed directly by some aspect of the Proposed Action, for example, providing access to habitat not now occupied by steelhead. The second element linked the issues in the first element with the magnitude of any anticipated changes in population abundance or productivity of coho or steelhead. In our answers in Section 3, we address principally the first element of the question. The second element is accessible only through the use of extensive data synthesis and analysis and population and life cycle models. This is a result of the multitude of influences on the fish populations, both under the Current Conditions and under the Proposed Action, operating at a variety of locations, timing, and life history stages, and potentially interacting. For example, fish abundance could increase if more spawning habitat were available, but only if the quantity or quality of existing spawning habitat limits production and if the production in the newly available habitat actually contributes to subsequent adult returns. None of these relationships is static; for example, limitation by spawning habitat may depend on the availability of gravel as well as subsequent availability of rearing habitat. Teasing apart these interactions requires a consideration of all affected stages of the life cycle, and conceptual and numerical life cycle models are an appropriate context in which to do this.

Some of the ingredients for at least conceptual life cycle models were in the various reports provided to the Panel. For example, Table 1 and Section 2.5 "Coho Salmon Conceptual Model" in Stillwater (2010) provide useful information. However, there was no single, unified presentation of a conceptual model and how it relates to dam removal and KBRA under the Proposed Action, and the numerical coho life cycle model was removed from consideration. More focus is needed to express the conceptual life cycle diagrams, and responses to the Proposed Action, in terms of the timing and habitat (location) of all life stages, and the factors affecting the processes of reproduction, growth, mortality, and movement of each stage in each habitat.

4.2 Notes on Modeling and Uncertainty (C-10)

The assessment involved a number of models to contrast conditions under the two alternative scenarios. Some of the models were used alone, and some were used in sequence with output of one providing input to the next. These models included simulations of hydrology (flow), water temperature, sediment movement, climate change, habitat availability in relation to flow, and habitat use by salmon. There is no coho population dynamics model under active consideration at present, though one was developed for this project and then removed from Panel consideration due to review issues. There is no steelhead model for this system that we are aware of. The NMFS, so far, has assessed "viability" of salmon populations in the Klamath with a qualitative scheme called VSP, which is not an explicit population model and does not contain formal representation of population dynamics.

The inputs to the modeling chain begin with the meteorological, flow, and water temperature records available for driving the models and for calibration and validation. We did not see mention of useful water temperature data predating the construction of the four lower dams. All calibration in the models we saw described appears to have been confined to times in the range roughly 1960 to the present. This presents a basic difficulty for calibrating and validating the modeling of the Proposed Action scenario because the exact river conditions without the dams is unknown and can only be approximated. As a substitute for validation data on the Proposed Action scenario, the temperature modeling should consider the likely errors in the estimates for the temperature dynamics for those river reaches which will emerge when the present reservoirs are drawn down. While the exact characteristics of the resulting channel are not yet known, reasonable approximations of their morphology and bed characteristics can be made.

The climate change analyses, which were used as inputs to some of the hydrology and temperature models for some scenarios, were reasonable and typical of how climate change is simulated in a site-specific application. Downscaled results from Global Climate Models (GCMs) show consistent responses of warmer temperatures, with uncertainty about the magnitude of warming, and high uncertainty about the direction and magnitude of any precipitation changes. Some of the hydrologic analyses provided to the Panel confirmed this general pattern that is also found in other site-specific analyses. These uncertainties were then propagated through the hydrology and temperature models, resulting in a bounding of the possible changes in flow and river temperatures. Given the uncertainties resulting from downscaling from the coarse spatial scales of the GCMs to the finer spatial scale of the hydrological models, the analyses performed were considered adequate by the Panel, but still leave work to be done in examining the potential for changes, particularly in low flows, at critical seasons. Higher resolution modeling of critical areas during important biological time periods under low flow conditions with climate change is feasible and would provide useful information on possible fish responses into the future.

A particular concern for the Klamath River is the role of groundwater dynamics and water demand, and how they may affect surface water hydrology under scenarios of climate change, human population growth, and economic development in the basin. It is not yet possible to anticipate how climate change might indirectly affect groundwater pumping in a largely unrecorded and unregulated environment if, for example, changes in stream flow and water use lead to unmet local water needs.

The Panel considered the hydrologic and some of the temperature modeling to be usefully acceptable, with some reservations. The need to calibrate such models with historical records in a hydrologic system that is continually being altered by sequences of droughts and by irregular exploitation through surface and groundwater extraction and other forms of water allocation is a well-known problem that reduces the accuracy of predictions. The models, if implemented carefully, can formalize consideration of the broad outline of changes to be expected. It is impossible in a 5-day review for a panel to examine the specific steps involved in model implementation in order to evaluate the robustness of model predictions. However, it is straightforward to recognize that the strategy of calibration of flow and lake levels has high uncertainty in a system where streamflow has been, and likely will be in the future, reduced by irrigation withdrawals and groundwater pumping decisions. Improvement in the understanding of the role of the socio-economic processes governing water diversions will require extensive studies of groundwater that are currently underway, as well as studies of the plasticity of water use.

The necessity to disaggregate the output of one model to match the finer time step of the next model can lead to loss of important information on variability. For example, in at least one set of analyses, the monthly flows simulated by MODSIM were simply disaggregated to daily flows to then be used as input to HEC-5Q, whose output of daily temperatures has questionable estimates of variability (see Section 3.2). Although more complicated models could have been used, the analyses of flow and temperature were deemed adequate for their intended purpose of contrasting the average temperatures downstream of Iron Gate Dam between the two scenarios (Current Conditions and the Proposed Action). The Panel is less convinced about the simulation of the higher-frequency temperature variations actually experienced by the fish. There is room for complementary use of even simpler models with higher temporal resolution to examine (for example) hourly variations of water temperatures at critical times of the year, and this strategy would not require either complexity or a heavy investment of time. More detailed modeling (e.g., 2-dimensional) would better describe the spatial and temporal variation in flow and temperature and help quantify thermal refugia, but would require a major modeling effort and extensive data collection for model calibration. If pursued, modeling of refugia would focus on specific examples of refugia that will yield general understanding of the nature of local responses to basin-wide trends (e.g., drought and water demand management). The value of this information relative to its cost depends on the degree to which use of thermal refuges influences productivity and persistence of the fish populations (see below).

The next models in the chain that would have provided useful insights should have been steelhead and coho life cycle models. The Panel was frustrated that the life cycle model for coho, which had been provided initially to the Panel, was withdrawn from our consideration just before the Panel meeting. It is unfortunate that the schedule for model review did not enable the model to be reviewed and considered by the Panel. A spatially-structured life cycle model is what is needed to incorporate influences of the Proposed Action on all parts of the life cycle and assimilate real data about the biological and physical changes that occur over seasons and over the entire spatial range of a species. A mathematical representation of the life cycle dynamics of coho (and steelhead) would provide the basis to formalize the specific issues and assumptions that need to be examined in the predictions of project effects. Model analyses using alternative parameter values and assumptions, in turn, can identify the critical data needs for monitoring and experiments. Information collected subsequently can then be used to refine the models, increasing the reliability of predicted fish responses to the two contrasting scenarios (Current Conditions and the Proposed Action). Model runs may reveal that some information that is missing or poorly known is actually unimportant, while other information is critical. This result can be used in prioritizing data gathering for subsequent improvements in the model or improvement to the analyses to provide a better understanding of population responses. The final result of this iterative process of modeling and data collection provides increasing reliability in model predictions of fish responses. The modeling enables disagreements to be clearly articulated and the possible differences to be bounded.

A model can serve a variety of legitimate purposes, depending on the degree of scrutiny it has passed. For a complex system such as salmon in the Klamath River, the first use of a model is simply as a vehicle to formalize a comprehensive representation of the available knowledge and hypotheses about the functioning of the system. This facilitates discussions and brainstorming for ensuring completeness of the model components and data sets, revealing possible gaps, and providing a platform to explore sensitivities to various components of the system or to possible changes in values of parameters. During this phase of development and testing, the model essentially serves as an organizing framework. Our comments in this report related to the desirability of incorporating a detailed spatially structured life cycle model in the assessment illustrated our sense that such a model component would help clarify the scientific thinking.

There is a tendency to over-use the models for making concrete quantitative predictions, but the legitimacy of that use requires quality control and quality assurance steps, assessment of prediction uncertainty, and a paper trail of model development and evaluation so that the customers who may want to use the predictions can be aware of the expectable reliability. Our review has touched lightly on these issues with respect to some of the temperature modeling. If and when fish life cycle models are added to the mix (and they should be), these issues will take on some immediacy, because the uncertainty of such population model projections is often quite large compared to the resolution desired for purposes of making a management decision.

4.3 Caveats and recommendations

The task of the coho and steelhead Panel occurs at a very early stage in the decade-long process of evaluation, planning, decision-making, and design leading up to a potential 2020 initiation of dam removal. Nevertheless, the decision whether to commit to that schedule is slated to be made fairly soon (the Secretarial Decision 2012). The Panel has been asked to make a scientific assessment of the impact of two strategies for river management (Current Conditions versus the Proposed Action) on coho and steelhead populations of the Klamath River Basin.

The questions posed to the Panel are very wide-ranging, overlapping, and not amenable to simple or exact answers. Providing such answers would require years of field investigations, which the agencies have not yet had the resources to conduct. The Panel members have been able to respond only through qualitative estimates based on evaluation of the fragmentary, conflicting evidence provided and their own scientific understanding and experience in other river systems. However, the review does highlight six obstacles to more confident conclusions about the likely differences between the two alternatives. Removal of these obstacles by well-planned studies in the near term would facilitate more effective design of the KBRA restoration effort. The obstacles are:

1. *Insufficient specificity in the current substance of the KBRA and the decision rules for its implementation.*

The anticipated habitat benefits from dam removal alone are relatively straightforward to estimate. The present specification of mitigation and restoration in the KBRA is vague; yet, it is likely to have a large, but difficult to predict, influence on the fish.

2. *Serious uncertainty about fish passage and colonization.*

The degree of upstream and downstream blockage or mortality for anadromous fish at Link and Keno dams, migration through Keno Reservoir and Upper Klamath Lake, and colonization of upper basin habitats are unknown. There is a significant probability that trap-and-haul programs will be necessary to reap the benefits to anadromous-fish habitat restoration in Upper Klamath basin. At present, the Panel was provided with inconsistent information about plans for trapping and hauling coho or steelhead. Certainly, removing dams is necessary for increased opportunity for upstream habitat usage; whether such opportunity is realized depends on effective passage and transit by the migrating fish and conditions for them in the upstream habitat.

3. *Serious uncertainty about the effects of hatchery fish introgression.*

Hatchery introgression could affect the development of well-adapted life histories in the wild stocks under the new conditions created by the Proposed Action, thereby reducing productivity of populations that may attempt to colonize new habitats. This concern would be reduced if the production hatchery was removed or if it was replaced with a conservation hatchery Existing natural populations probably have reduced fitness as a result of introgression.

4. *Uncertainty about the potential to control mortality of coho due to parasites in the Klamath River mainstem.*
5. *Uncertainty about how land owners will accommodate to KBRA.*

This specifically relates to purchases of surface water or to increasing water demands in the future with climate change, particularly because no regulatory system appears to be in place to govern compensatory pumping of ground water.

6. *Lack of comprehensive understanding (numbers, dynamics, habitat use, migration patterns, and life history) of the natural-origin salmon stocks of interest.*

With this degree of uncertainty, expert opinion expressed as numbers, even when obtained from experienced specialists, would be inexact, misleadingly concrete, and vulnerable to inappropriate over-interpretation. Nevertheless, it is possible to define pathways for *reasoning* about potential outcomes on the basis of information about the Klamath system, experience transferred from analogous situations elsewhere, and well-established, tested, and widely applicable scientific principles. Such reasoning can also define and state its own limits, and highlight where decisions will have to be made in the face of great uncertainty that may be irresolvable in time for the Secretarial Determination in 2012.

Furthermore, *a decision to proceed with the projects should be understood as a decision to pursue a hypothesis of increased fish production, for which there is evidentiary support for qualitative responses, but whose quantitative outcome is largely unknown.* Large-scale restoration, such as the Proposed Action alternative, have great potential for benefiting the targeted species, but can also easily become ineffective due to the complexities of the plan and the ecosystem. In this spirit, the Panel highlights the following four important topics:

a. The processes, controlling factors, and hazards likely to have the greatest influence on project outcomes could be identified ***now***.

b. Experiments and studies could be carried out between ***now and the planned date for dam removal (2020)*** to reduce some of the uncertainties, which in turn could provide guidance and direction for the KBRA.

c. Monitoring programs could be planned, coordinated, and implemented ***now*** for effective and timely detection of the consequences for the salmon of the grand experiment comprising the dam removal and KBRA program. A monitoring program could be designed and established ***soon*** to provide useful and timely guidance for KBRA and the design of dam removal.

d. A scientific advisory structure could be implemented ***at the beginning of the planning process*** to advise continually on effective and timely adaptation of KBRA mitigation and restoration activities in response to monitoring and experimental results, to identify ineffective and counterproductive activities, and to recommend new ideas and maintaining and fine-tuning activities that prove effective.

"Expert opinion" even of an independent panel should not be used as a substitute for scientific analysis. The Panel was provided with qualitative information and asked to respond to questions that should be answered with more than qualitative (i.e. ideally quantitative) answers. A short-term expert panel cannot do a comprehensive synthesis of this mass of disjointed information in a short period of time. The Panel's role is to clarify issues and provide a view from outside of the agencies and an independent evaluation of the available information. Although this report is structured as answers to the questions posed to the Panel, the most frequent response is that we did not have sufficient information to truly answer the questions.

The presentations we were shown on December 13, 2010 did not convey an effective, comprehensive view of the project as a whole. We are concerned that this may reflect on the coherence of the project's design and execution. The proposed restoration program would benefit greatly by developing and communicating a clear overall conceptual model, which then could be fleshed out with explicit modeling and statistical testing against observations. The program is large and complex and subject to controversy, and involves multiple species with a wide variety of life history strategies. Nevertheless, there is an underlying logic that would provide organizing principles for assessment. Each target species must complete its entire life cycle in order for any benefits of the Proposed Action to be fully manifested, and for the goals of the program (sustaining fish populations) to be met. The life cycles of each species should be described through time and space in this system, and then the logical connections from the actions to the life stages and processes (e.g., spawning, juvenile growth) explained. The Panel recognizes that such information must have contributed to the thinking that led to the development of the KBRA. Although some of this information might be latent in the documentation, the information is fragmentary and scattered among different documents. In its present form, the restoration plan comprises dam removal and a long list of vaguely-defined KBRA actions, only partially supported by a mix of limited quantitative modeling of abiotic factors (e.g., sediment transport, flow, and temperature) which, in its present form, cannot be integrated to predict effects on fish. This makes assessing the likely responses to the Proposed Action difficult, qualitative, and overly reliant on subjective opinion. Formulating a single, overall conceptual model for each species across all possible actions will focus the plan, and allow identification of areas of disagreement or uncertainty about likely responses to actions, and help reduce uncertainty and resolve disputes through specific scientific investigations.

The Panel is heartened to see the quantitative analyses to date, and urges an expansion in scope of these analyses. Expertise for additional quantitative analyses such as habitat and life cycle modeling is available in the agencies and their contractors, and ought to be brought into the planning of the restoration program. Difficulties in securing the services of personnel skilled in these analyses should not be allowed to impede development of an overall, predictive model, or specific quantitative analyses. The Panel strongly emphasizes the value of making the agencies' expertise in quantitative analyses and available to the offices responsible for the restoration program.

The Panel also questions some of the timing of when information is available relative to the expert panel meetings. Critical material, such as some of the daily flow modeling and the description of estimation methods for the monthly flow modeling, was made available to the Panel in draft form and with some lingering questions about the methods and results, especially the daily flow data. There is an enormous amount of information on salmonids, and greater synthesis and presentation of the evidence from all viewpoints on key scientific issues prior to the meeting would have increased the effectiveness of this Panel. The Panel was asked to do more synthesis and integration on its own than was practicable and optimal in the brief period allotted to the panel meeting. The Panel understands that the analyses are complicated and ongoing, and thus suggests that either greater synthesis be done in advance and key analyses be confirmed prior to panel meetings, or that panel meetings be scheduled when such information can realistically be made available. Perhaps repeated panel meetings, designed to occur periodically throughout the evaluation process, could ensure maximum use of the expert panels.

The KBRA restoration program should give scientific leadership a prominent role in program design and implementation. The KBRA restoration program would benefit from having a Lead

Scientist to coordinate and promote monitoring and research plans, and to explain the implications of scientific findings to decision-makers and designers of the proposed project. The Proposed Action is obviously controversial, and it is of national importance and prominence. In similar situations elsewhere, having a single person in charge of coordinating and dealing with science, and able to separate science from other issues, has greatly helped to keep discussions and arguments clear, focused, and integrated. The Proposed Action is complicated and expensive. If the decision is made in favor of the Proposed Action, it is anticipated to continue for decades. Knowledge gained through monitoring and scientific investigations during that time will be invaluable for adjusting the course of the program to maximize benefits. If the decision is made to proceed with the Proposed Action, then monitoring and research plans should be immediately formulated and begun. Most of the key science issues have already been identified (though not resolved) or can be anticipated. However, to date, the program has under-invested in monitoring and analysis. A suitable advisory body with a single leader can help to ensure that such monitoring proceeds.

Centralized scientific leadership can also ensure effective use of peer review. The Panel heard several times at the briefing that a report had been "peer-reviewed." There are several definitions of peer review, and they vary greatly in rigor. An essential element of peer review is the response to the reviews and the subsequent changes that were made. Peer review should include the disclosure of review comments and the response to the review comments, and in many cases, subsequent evaluation of the adequacy of the response by an impartial intermediary.

As the program matures, scientific leadership will play a crucial role in overseeing the development and maintenance of a central shared database for all the accumulating data, in coordinating the integration and coupling of linked models, and in fostering a setting where scientific disagreements can be resolved on the scientific merits.

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APPENDIX A
Panelists' Resumes

THOMAS DUNNE: CURRICULUM VITAE

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PROFESSIONAL PREPARATION:
Cambridge Univ., Geography, B.A. 1964
Johns Hopkins University, Geography, Ph.D. 1969

APPOINTMENTS:
1995- Professor, Donald Bren School of Environmental Science and Management, and Department of Earth Science, University of California, Santa Barbara
1973-1995 Asst. Prof. to Professor, Dept. of Geological Sciences, Univ. of Washington (Chair 1984-1989)
1971-1973 Assistant Professor, Department of Geography, McGill University, Canada,
1969-1971 Visiting Professor, Department of Geography, University of Nairobi, Kenya.
1968-73 (WAE) Research Hydrologist, Water Resources Division, US Geological Survey, Washington DC
1966-1968 Research Associate, Agricultural Research Service, US Department of Agriculture, Vermont

CURRENT RESEARCH INTERESTS IN HYDROLOGY AND GEOMORPHOLOGY

1. Field and theoretical studies of drainage basin and hillslope evolution

2. Hydrology, sediment transport, and sedimentation in river channels and floodplains

3. Sediment transport, channel migration, and oxbow lake sedimentation in rivers of the Central Valley, California.

Thomas Dunne is a Professor of Environmental Science and Management, and of Earth Science at the University of California Santa Barbara. He conducts field and theoretical studies of drainage-basin, hillslope, and fluvial geomorphology, and in the application of hydrology, sediment transport, and geomorphology to landscape management and hazard analysis.

While working for the USDA Agricultural Research Service (1966-1969) and McGill University (1971-1973), he conducted research on the effects of topography, soil characteristics, and vegetation on runoff processes under rainfall and snowmelt in Vermont and Canada. While teaching at the University of Nairobi, Kenya (1969-1971), he initiated a long-running research interest in African environments, including experimental studies of runoff and erosion processes, and statistical studies and field surveys of the effects of land use on hillslope erosion and river-basin sediment yields. He continues to use data from the experimental studies to model sediment transport and hillslope evolution, one of his long-term research interests. He also conducted occasional studies of reservoir sedimentation, water quality, and erosion due to charcoal production and grazing. This work was supported by the Rockefeller, Guggenheim, and Beijer Foundations, the United Nations Development Programme, U.S. National Science Foundation, and Kenya government agencies between 1969 and 1991.

While teaching in the Department of Geological Sciences at the University of Washington (1973-1995), he studied landsliding and debris flows; drainage-basin sediment budgets in natural and managed forests; tephra erosion and debris-flow sedimentation on active volcanoes; and sediment transport and channel morphology in sand-bed and gravel-bed river channels. He also conducted several studies related to resource management, such as the impacts of gravel harvesting on the river-channel sedimentation and morphology; impacts of timber harvest on erosion and sedimentation; and effects of flow diversion and reservoir management on sedimentation. The work was funded by NSF, and various state agencies (Depts. of Ecology and of Natural Resources), and federal agencies (USFS, USGS, FEMA).

Since moving to California he has studied hydrology, sediment transport, and floodplain sedimentation in the Amazon River of Brazil and in the Andes Range and adjacent floodplains of eastern Bolivia. His work, funded by NSF and NASA, involved studies of runoff processes in forest and pastures, modeling of the runoff response of the Amazon River, channel and bed material surveys, floodplain coring to measure rates of sediment accumulation with isotopes, measurement and interpretation of channel change and floodplain features from satellite images, flow and sediment transport modeling in channels and floodplains, and erosion of the Andes Range and sedimentation in the adjacent foreland basin with meteoric and cosmogenic isotopes.

He and his students have studied runoff and erosion on rangeland hillslopes and small wildland and urbanized watersheds around Santa Barbara, and as well as sediment transport, channel change and oxbow lake sedimentation along the Sacramento River and its floodplain. With five biologist colleagues in the Bren School, his group now studies how physical and biological processes interact to create and maintain habitat for fish and their food sources in the Merced and San Joaquin Rivers, CA. Funds are provided by the California Bay-Delta Restoration Science Program and the California Department of Water Resources.

He has gained experience with geomorphic and hydrologic processes through research and consultation in many parts of the world, and has expressed some of that experience in teaching courses, advising government and international agencies, publishing journal articles, and co-authoring two textbooks.

HONORS

Fulbright Scholar, 1964
Robert E. Horton Award, American Geophysical Union, 1987
Member, National Academy of Sciences, 1988
Fellow, American Geophysical Union, 1989
Guggenheim Fellowship, 1989
Fellow, American Academy of Arts and Sciences, 1993
Fellow, California Academy of Sciences, 1996
National Research Council Wolman Distinguished Lecturer, 1997
National Academy of Sciences Warren Prize for Fluviatile Geology, 1998
Bren School Distinguished Teaching Award, 2002, 2008
American Geophysical Union Langbein Lecturer, 2003
Geological Society of America Easterbrook Distinguished Scientist Award, 2003
Borland Distinguished Lecturer in Hydraulics, Colorado State University, 2007
Linton Award, British Society for Geomorphology, 2008.
Elected Honorary Member, Japanese Geomorphological Union, 2009

SOME RECENT PUBLICATIONS

T. Dunne, J. A. Constantine, and M. B. Singer, The Role of Sediment Transport and Sediment Supply in the Evolution of River Channel Complexity and Floodplain Evolution, **Transactions Japanese Geomorphological Union**, 2010.

T. Dunne, D. V. Malmon, and S. M. Mudd, A rainsplash transport equation assimilating field and laboratory measurements, **Journal of Geophysical Research – Earth Surface,** 2009.

J. A. Constantine, T. Dunne, H. Piégay, and G. M. Kondolf, Controls on the alluviation of oxbow lakes by bed-material load along the Sacramento River, California, **Sedimentology**, 2009.

J. A. Constantine, S. R. McLean, T. Dunne, A Mechanism of Chute Cutoff along Large Meandering Rivers with Uniform Floodplain Topography, **Geological Society of America Bulletin**, 2009.

C. R. Constantine, T. Dunne, and G. J. Hanson, Examining the physical meaning of the bank erosion coefficient used in meander migration modeling, **Geomorphology**, 106, 242-252, 2009.

R. E. Beighley, K. G. Eggert, T. Dunne, Y. He, V. Gummadi and K. L. Verdin, Simulating Hydrologic and Hydraulic Processes Throughout the Amazon River Basin, **Hydrological Processes,** 23, 1221-1235, DOI: 10.1002/hyp.7252, 2009

J. A. Constantine and T. Dunne, Meander Cutoff and the Controls on the Production of Oxbow Lakes, **Geology**, 2008.

R. E. Beighley, T. Dunne and J.M. Melack**,** Impacts of climate variability and land use alterations on frequency distributions of terrestrial runoff loading to coastal waters in southern California, **Journal of the American Water Resources Association**, 44(1), 62-71, 2008.

T. W. Biggs, T. Dunne, D. Roberts, and E. Matricardi, The rate and extent of deforestation in watersheds of the southwestern Amazon basin: implications for regional stream biogeochemistry, **Ecological Applications**, 18(1), 31–48, 2008.

L. A. K. Mertes and T. Dunne, The effects of tectonics, climatic history, and sea-level history on the form and behavior of the modern Amazon River, In: **Large Rivers** (ed. A. Gupta), Wiley & Sons, pp. 115-144, 2007

D. Alsdorf, P. Bates, J. Melack, M. Wilson, and T. Dunne, Spatial and temporal complexity of the Amazon flood measured from space, **Geophysical Research Letters**, 34, L08402, doi:10.1029/2007GL029447, 2007

E. B. Safran, A. Blythe, T. Dunne, Spatially Variable Exhumation Rates in Orogenic Belts: An Andean Example, **Journal of Geology**, 114, 665-681, 2006.

R. E. Aalto, T. Dunne, and J-L Guyot, Geomorphic controls on Andean denudation, **Journal of Geology,** 114, 85-99, 2006.

J. M. de Moraes, A. E. Schuler, T. Dunne, R. O. Figueiredo, and R. L. Victoria, Water storage and runoff processes in plinthic soils under forest and pasture in Eastern Amazonia, **Hydrological Processes**, 20 (12), 2509-2526, 2006

M. B. Singer and T. Dunne, Modeling the decadal influence of river rehabilitation scenarios on flow and sediment transport in large, lowland river basins, **Water Resources Research**, 42, W12415, doi:10.1029/2006WR004894, 2006

E. B. Safran, P. Bierman, R. Aalto, T. Dunne, K. X Whipple, and M. Caffee, Erosion rates driven by channel network incision in the Bolivian Andes, **Earth Surface Processes and Landforms**, 30 (8):1007-1024, 2005.

D. V. Malmon,S. L. Reneau, T. Dunne, D. Katzman, and P. G. Drakos, Influence of sediment storage on downstream delivery of contaminated sediment, **Water Resources Research,** 41, W05008, doi:10.1029/2004WR003288, 2005

D. V. Malmon, S. L. Reneau, and T. Dunne, Sediment sorting by flash floods, **Journal of Geophysical Research – Earth Surface**, 109(F2), 2004**.**

E. J. Gabet and T. Dunne, A stochastic sediment delivery model for a steep, Mediterranean landscape, **Water Resour. Res.,** 39, doi:10.1029/2003 R00234, 2003.

OTHER PROFESSIONAL ACTIVITIES

National Research Council Committees

Environmental Aspects of National Materials Policy, 1972-73
International Environmental Programs, 1979-82
Working Group on Managemt of Renewable Natural Resources in Nepal, Kathmandu, 1981
U. S. Army Basic Research, 1983-88
U. S. Geological Survey Water Resources Research, 1987-89
Opportunities in the Hydrological Sciences, 1987-89
Alluvial Fan Flooding, 1994-96
Future Roles, Challenges, and Opportunities for the U.S. Geological Survey, 1998-2000
Water Resources Activities of the U.S. Geological Survey, 2006-2009
Challenges and Opportunities in Earth Surface Processes, 2007-2009

Missouri River Recovery and Associated Sediment Management Issues, 2008-2010
U.S. National Committee for the lnternational Union of Geological Sciences, 2009-13
Sustainable Water and Environmental Management in the California Bay-Delta, 2010-2013

United Nations

UNESCO Research team on Nzoia R., Kenya, 1970-71
FAO Consultant on Soil Erosion and Desertification in Kajiado District, Kenya, 1976
FAO Committee on Soil Erosion and Soil Conservation in Developing Countries, Rome, 1976
FAO/UNEP Committee on a Methodology for Assessing World Soil Degradation, Rome, 1978

Other Committees

Kenya National Committee on the Human Environment, Nairobi, 1970-71
Washington State Governor's Commission on Snohomish R. Basin, 1975
International Geographical Union, Commission on Field Experiments in Geomorphology, 1976-84 (Secretary, 1980-84).
Geological Society of America, Committee on the Penrose Medal, 1988-1990; Co-chair of Program Committee for 1994 Annual Meeting.
American Geophysical Union, Committee on the Horton Medal, 1990-1994, (Chair 1992-1994); Union Committee of Fellows (1992-1994)
Oregon State Legislature, Blue Ribbon Panel on Anadromous Fish Populations and Forest Practices, 1993-1995.
State of California Bay-Delta Ecosystem Restoration Program, Scientific Review Panel, 1997.
MEDEA Project on the Use of Remote Sensing in Environmental Analysis, 1997-2000
California Department of Forestry and Fire Protection/Univ. of California Committee on the Scientific Basis on the Prediction of Cumulative Watershed Effects (chair), 1998-2001.
State of Washington Panel on Salmon Conservation Validation Monitoring, 2000.
State of California Bay-Delta Ecosystem Restoration Program Science Board, 2000-2005.
U.S. Fish and Wildlife Service, Adaptive Management Forum for San Joaquin River Restoration, 2001-2003.
Sustainable Ecosystems Institute, Portland, Scientific Panel on the Columbia River Channel Improvement Project, 2001.
State of California Bay-Delta Program Independent Science Board, 2003- 2005(Chair).
Iraq Foundation, Eden Again Project, Technical Advisory Panel on Restoration of the Mesopotamian Marshlands, 2003.
National Academy of Sciences Warren Award Committee (Chair 2004, 2006)
American Institute of Hydrology Award Committees (Theis Award 2006; Linsley Award 2007)
Sustainable Ecosystems Institute, Portland, Scientific Panel to Review the Missouri River Pallid Sturgeon Restoration Project (2008)
National Science Foundation Steering Committee for the Community Surface Dynamics Modeling System (2007-2009)
National Science Foundation, Steering Committee for MARGINS (2008-2009).
National Science Foundation, Review Committee for the Hydrological Synthesis Project (2008-2011)
California Bay-Delta Conservation Program -- Independent Science Advisor on Adaptive Management (2008-2009)
US Department of the Navy, Naval Research Laboratory, Marine Geosciences Division, External Review of Research Program on Battlespace Environments and Undersea Warfare Technology (2009)

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CURRICULUM VITAE

GREGORY T. RUGGERONE

EDUCATION

Ph.D. Fisheries, University of Washington, 1989.
M.S. Fisheries, University of Washington, 1981.
B.S. Biological Sciences, University of California, Irvine, 1978.

EXPERIENCE

1993-present	Vice-President, Fisheries Scientist, Natural Resources Consultants, Inc. Responsible for salmon investigations in the Pacific Northwest and Alaska. Affiliated research scientist, Alaska Salmon Program, School of Fisheries, University of Washington.
1990-1993.	Principal Fisheries Biologist. University of Washington, Fisheries Research Institute. Project Leader/ Co-PI, Alaska Salmon Program. Responsible for directing several research projects at FRI's Alaska field stations and supervision of graduate students.
1989-1990.	Senior Fisheries Biologist. University of Washington, Fisheries Research Institute. Project Leader for the Alaska Salmon Program (see above responsibilities).
1984-1989.	Predoctoral Research Associate. University of Washington, Fisheries Research Institute. Project Leader for the Chignik Lakes Salmon Research Program. Responsible for directing research projects and supervision of students.
1982-1984.	Fisheries Biologist. Jones & Stokes Associates, Inc. Responsible for environmental studies related to fish and fisheries in Alaska, Washington and California.
1982.	Consultant. BioSonics, Inc. Examined juvenile salmon migration at a Columbia River dam using hydroacoustic techniques.
1979-1981.	Research Assistant. University of Washington, Fisheries Research Institute. Field research on salmon at the Wood River lakes, Alaska.

1978-1979. Biologist. California Department of Fish and Game. Assisted several marine fisheries projects, including the annual CALCOFI anchovy survey.

1978. Biologist. University of California, Irvine. Department of Ecology and Evolutionary Biology. Received Student-Originated-Studies grant from the National Science Foundation to examine the effects of groundwater removal on natural spring communities in the Owens Valley, CA.

1977-1978. Lab Technician. University of California, Irvine. Department of Ecology and Evolutionary Biology. Field biologist for rocky intertidal studies.

PROFESSIONAL SERVICE

Society Memberships

American Institute of Fishery Research Biologists, NW District Director (1993-1994), Regional Director (1994-1995)
American Fisheries Society

Scientific Referee

Aquatic Living Resources
Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative
American Fisheries Society
Canadian Journal of Fisheries and Aquatic Sciences
First International Symposium on GIS in Fishery Science
Fisheries Oceanography
Fishery Bulletin
Fourth World Fisheries Congress, American Fisheries Society
Gulf of Alaska Ecosystem Monitoring Program (GEM)
Gut Shop 1993
Marine Stewardship Council
National Science Foundation
Nature
North American Journal of Fisheries Management
North Pacific Research Board
North Pacific Anadromous Fish Commission
Marine Stewardship Council
Ohio Sea Grant College Program
Pacific Salmon and Their Ecosystems: Status and Future Options
PICES
Reviews in Fish Biology and Fisheries
Transactions of the American Fisheries Society
West Coast National Undersea Research Center, NOAA

Committees
Science Technical Committee, Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative
Chignik Regional Aquaculture Association, Scientific Advisor
Independent Scientific Advisory Board, Columbia River, Ad Hoc member

AWARDS AND SCHOLARSHIPS

American Institute Fisheries Research Biologists, Research Award, 1992 (Visiting scientist in Russia)
John Cobb Memorial Scholarship, 1989
American Institute Fisheries Research Biologists, Research Award, 1988
Seattle Poggie Club (Fisheries) Scholarship, 1986
National Science Foundation Student-Originated-Studies Grant, 1978
University of California, Irvine President's Council Grant, 1977
Dean's Honor List: 1974, 1975, 1976, 1977

SUPERVISION OF GRADUATE STUDENT RESEARCH

Griffiths, J. 2009. Assessing the implications of changing geomorphology and climate on the habitat characteristics of Black Lake, Alaska. M.S. Thesis. University of Washington, Seattle.

Westley, P. 2007. Biocomplexity and rapid natural habitat change in the Chignik Lake system, Alaska. M.S. Thesis. University of Washington, Seattle.

Chasco, B. 2004. Inseason run size forecasting of Chignik sockeye salmon. M.S. Thesis. University of Washington, Seattle.

Harvey, C.J. 1994. Upstream migration of fishes in Black River, Chignik Lakes, Alaska. M.S. Thesis. University of Washington, Seattle. 154 p.

Bumgarner, J.D. 1993. Long-term trends in the growth of sockeye salmon from the Chignik Lakes, Alaska. M.S. Thesis. University of Washington, Seattle. 86 p.

Hanson, R. 1992. Brown bear (*Ursus arctos*) predation on sockeye salmon spawners in two tributaries of the Wood River Lake system, Bristol Bay, Alaska. M.S. Thesis. University of Washington, Seattle. 124 p.

Berejikian, Barry A.. 1992. Feeding Ecology of Rainbow Trout with Comparisons to Arctic Char in Iliamna Lake, Alaska. M.S. Thesis. University of Washington, Seattle. 72 p.

Zimmermann, M. 1991. Trends in the freshwater growth of sockeye salmon from the Wood River Lakes and Nushagak Bay, Alaska. M.S. Thesis. University of Washington, Seattle. 119 p.

PUBLICATIONS

Journals and Book Chapters

Ruggerone, G.T., J.L. Nielsen, and B.A. Agler. 2009. Linking marine and freshwater growth in western Alaska Chinook salmon, *Oncorhynchus tshawytscha*. Journal of Fish Biology 75: In press.

Ruggerone, G.T., J.L. Nielsen, and B.A. Agler. 2009. Climate, growth and population dynamics of Yukon River Chinook salmon. North Pacific Anadromous Fisheries Commission Bulletin. In Press.

Ruggerone, G.T., and J.L. Nielsen. 2009. A review of growth and survival of salmon at sea in response to competition and climate change. American Fisheries Society Symposium 70: In press.

Ruggerone, G.T., R.M. Peterman, B. Dorner, and K.W. Myers. 2009. Magnitude and trends in abundance of hatchery and wild pink, chum, and sockeye salmon in the North Pacific Ocean. In review.

Ruggerone, G.T., S. Goodman, and R. Miner. 2009. Behavioral response and survival of juvenile coho salmon to pile driving sounds. In review.

Westley, P.A.H., R. Hilborn, T.P. Quinn, G.T. Ruggerone, and D.E. Schindler. 2008. Long-term changes in rearing habitat and downstream movement by juvenile sockeye salmon (*Oncorhynchus nerka*) in an interconnected Alaska lake system. Ecology of Freshwater Fish 17:443-454.

Ruggerone, G.T., J.L. Nielsen, and J. Bumgarner. 2007. Linkages between Alaskan sockeye salmon abundance, growth at sea, and climate, 1955-2002. Deep Sea Research II 54:2776-2793.

Rand, P.S., C.P. Kellon, X. Augerot, M. Goslin, J.R. Irvine, and G.T. Ruggerone. 2007. Comparison of sockeye salmon (*Oncorhynchus nerka*) monitoring in the Fraser River basin, British Columbia, Canada and Bristol Bay, Alaska. North Pacific Anadromous Fish Commission Bulletin 4:271-284.

Nielsen, J.L. and G.T. Ruggerone. 2007. Climate Change and a Dynamic Ocean Carrying Capacity: Growth and Survival of Pacific Salmon at Sea. *Proceedings Pacific Salmon Environment and Life History Models: Advancing Science for Sustainable Salmon.* American Fisheries Society Symposium, Anchorage, AK. September, 2005. In press.

Ruggerone, G.T. and F. Goetz. 2004. Survival of Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*) in response to climate-induced competition with pink salmon (*O. gorbuscha*). Canadian Journal Fisheries and Aquatic Sciences 61:1756-1770.

Ruggerone, G.T., and J.L. Nielsen. 2004. Evidence for competitive dominance of pink salmon (*Oncorhynchus gorbuscha*) over other salmonids in the North Pacific Ocean. Reviews in Fish Biology and Fisheries. 14:371-390.

Ruggerone, G.T., M. Zimmermann, K.W. Myers, J.L. Nielsen, and D.E. Rogers. 2003. Competition between Asian pink salmon (*Oncorhynchus gorbuscha*) and Alaskan sockeye salmon (*O. nerka*) in the North Pacific Ocean. Fisheries Oceanography. 12:3:209-219.

Nielsen, J. L. and G. T. Ruggerone. 2005. Global change, anthropomorphic effects and nonlinearity in Bering Sea sockeye salmon populations. *In* V.R. Burkett, D. A. Wilcox, R. Stottlemyer, W. C. Barrow, D. B. Fagre, J. Barton, J. Price, J. L. Nielsen, C. Allen, D. L. Peterson, G. Ruggerone, and T. Doyle. Nonlinear dynamics in ecosystem response to climate change: Case studies and resource management implications. Ecological Complexity 2: 357-394.

Ruggerone, G.T., E. Farley, J. Nielsen, and P. Hagen. 2005. Seasonal marine growth of Bristol Bay sockeye salmon (*Oncorhynchus nerka*) in relation to competition with Asian pink salmon (*O. gorbuscha*) and the 1977 ocean regime shift. Fishery Bulletin 103:2:355-370.

Ruggerone, G.T., and D. Rogers. 2003. Multi-year effects of high densities of sockeye salmon spawners on juvenile salmon growth and survival: a case study from the *Exxon Valdez* oil spill. Fisheries Research. 6:379-392.

Quinn, T.P., S.M. Gende, G.T. Ruggerone and D.E. Rogers. 2003. Density dependent predation by brown bears (*Ursus arctos*) on sockeye salmon (*Oncorhynchus nerka*). Canadian Journal of Fisheries and Aquatic Sciences 60: 553-562.

Ruggerone, G.T., J. Nielsen, E. Farley, S. Ignell, P. Hagen, B. Agler, D. Rogers, J. Bumgarner. 2002. Long-term trends in annual Bristol Bay sockeye salmon scale growth at sea in relation to sockeye abundance and environmental trends, 1955-2000. North Pacific Anadromous Fish Commission Tech. Rept. 4:56-58.

Ruggerone, G.T., R. Hansen and D. Rogers. 2000. Selective predation by brown bears (*Ursus arctos*) foraging on spawning sockeye salmon. Canadian Journal of Zoology 78:6:974-981.

Ruggerone, G.T. 2000. Differential survival of juvenile sockeye and coho salmon exposed to low dissolved oxygen during winter. Journal Fish Biology 56:1013-1016.

Mahnken, C., G. Ruggerone, W. Waknitz, and T. Flagg. 1998. A historical perspective on salmonid production from Pacific rim hatcheries. North Pacific Anadromous Fish Commission Bulletin 1:38-53.

Harvey, C.J., G.T. Ruggerone, and D.E. Rogers. 1997. Migrations of three-spined stickleback, nine-spined stickleback, and pond smelt in the Chignik catchment, Alaska. Journal of Fish Biology. 50: 1133-1137.

Ruggerone, G.T and C.J. Harvey. 1995. Age-specific use of habitat by juvenile coho salmon and other salmonids in the Chignik Lakes Watershed, Alaska. Pages 45-60 *in* Salmon Ecosystem Restoration: Myth and Reality (M.L. Keefe, ed.). Proceedings of the 1994 Northeast Pacific Chinook and Coho Salmon Workshop. American Fisheries Society. Eugene, OR.

Rogers, D.E. and G.T. Ruggerone. 1993. Factors affecting the marine growth of Bristol Bay sockeye salmon. Fisheries Research 18: 89-103.

Ruggerone, G.T and D.E. Rogers. 1992. Predation of sockeye salmon fry by juvenile coho salmon in the Chignik Lakes, Alaska: implications for salmon management. North American Journal of Fisheries Management. 12: 87-102.

Ruggerone, G.T. 1992. Threespine stickleback aggregations create potential predation refuge for sockeye salmon fry. Canadian Journal of Zoology 70: 1052-1056.

Ruggerone, G.T. 1992. Predation on sockeye salmon by fish and wildlife in Alaska. Pp. 20-21. In C.D. Levings and G.A. Hunter (eds), An Account of a Workshop on Research Approaches to Predation/Competition Questions in River Fish Communities. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2150.

Rogers, D.E., and G.T. Ruggerone. 1992. FRI forecasts of the 1992 sockeye run to Bristol Bay. Pp. 13-16 *in* 1992 Alaska Salmon Markets, G. Knapp (ed.). University of Alaska, Fairbanks.

Ruggerone, G.T. 1991. Salmon redux (salmon population resilience and habitat in Alaska). BioScience 41: 284.

Ruggerone, G.T. 1991. Partial xanthism in an adult chum salmon (*Oncorhynchus keta*) near Chignik, Alaska. California Fish and Game 77: 55-56.

Ruggerone, G.T, T.P. Quinn, I. McGregor and T.D. Wilkinson. 1990. Horizontal and vertical movements of maturing steelhead trout, *Oncorhynchus mykiss*, in Dean and Fisher channels, British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 47: 1963-1969.

Ruggerone, G.T. 1989. Coho salmon predation on juvenile sockeye salmon in the Chignik Lakes, Alaska. Ph.D. Dissertation. University of Washington, Seattle. 151 p.

Ruggerone, G.T. 1989. Gastric evacuation of single and multiple meals by piscivorous coho salmon, *Oncorhynchus kisutch*. Environmental Biology of Fishes 26: 143-147.

Ruggerone, G.T. 1989. Gastric evacuation rates and daily ration of piscivorous coho salmon (*Oncorhynchus kisutch*) Walbaum. Journal of Fish Biology 34: 451-463.

Ruggerone, G.T. 1986. Consumption of migrating juvenile salmonids by gulls foraging below a Columbia River dam. Transactions of the American Fisheries Society 115: 736-742.

Perkins, D.J., B.N. Carlsen, R.N. Miller, C.M. Rofer, G.T. Ruggerone, M.F. Fredstrom, and C.S. Wallace. 1984. Effects of groundwater removal on natural spring communities in the Owens Valley, CA. Pp. 515-527 *in* R. E. Warner and K.M. Hendrix, eds. California Riparian Systems: Ecology, Conservation, and Productive Management. University of California Press, Berkeley, CA.

Ruggerone, G.T. and D.E. Rogers. 1984. Arctic char predation on migrating sockeye smolts at Little Togiak River, Alaska. Fishery Bulletin 82: 401-410.

Technical Reports

Rogers, D.E. and G.T. Ruggerone. 1980. Alaska salmon studies: The study of red salmon in the Nushagak District. Ann. Rep. FRI-UW-8019. University of Washington, Seattle. 48 p.

Ruggerone, G.T. 1981. Arctic char predation on migrating sockeye smolts at Little Togiak River, Alaska. M.S. Thesis. Fisheries Research Institute, University of Washington, Seattle. 57 p.

Ruggerone, G.T. 1982. Salmonid habitat quality of 22 creeks in the Mt. Baker/Snoqualmie National Forest, Washington. Prepared for the U.S. Forest Service with Jones & Stokes Associates, Bellevue, WA. 40 p.

Ruggerone, G.T. and R. Denman. 1982. Salmonid spawning and rearing habitat survey: Illabot Creek. Prepared for Seattle City Light with Jones & Stokes Associates, Bellevue, WA. 15 p.

Ruggerone, G.T. 1983. Fishery enhancement potential of the Hanford Reach, Columbia River. Prepared for U.S. Army Corps Engineers, Seattle District, with Jones & Stokes Associates, Bellevue, WA. 64 p.

Van Veldhuizen, H. and G.T. Ruggerone. 1983. Analysis of Ocean Discharge Criteria Evaluation limitations for the St. George Basin (Lease Sale 70, southeastern Bering Sea). Prepared for the Environmental Protection Agency with Jones & Stokes Associates, Bellevue, WA.

Van Veldhuizen, H. and G.T. Ruggerone. 1983. Analysis of Ocean Discharge Criteria Evaluation limitations for Navarin Basin (Lease Sale 83, Bering Sea). Prepared for the Environmental Protection Agency with Jones & Stokes Associates, Bellevue, WA. 37 p.

Van Veldhuizen, H., J. Cabreza, G.T. Ruggerone and others. 1983. Ocean Discharge Criteria Evaluation: Diapir Field OCS Lease Sale 71 (Arctic Ocean). Prepared for the Environmental Protection Agency with Jones & Stokes Associates, Bellevue, WA. 175 p.

Ruggerone, G.T., and M. Green. 1984. San Antonio Creek hydroelectric project: Exhibit E. Application for exemption for a small hydroelectric project from licensing. Prepared for Jones & Stokes Associates, Sacramento, CA. 22 p. 1984.

Ruggerone, G.T. 1984. Review of the Draft EIS (fisheries section) for the Susitna River, Alaska, hydroelectric project. Prepared for the Environmental Protection Agency with Jones & Stokes Associates, Bellevue, WA. 41 p.

Van Veldhuizen, H., R. Denman, G.T. Ruggerone and A. Godbey. 1984. Environmental assessment of alternative seafood waste disposal methods at Akutan Harbor, Alaska. Prepared for the Environmental Protection Agency with Jones & Stokes Associates, Bellevue, WA. 97 p.

Van Veldhuizen, H., J. Cabreza, G.T. Ruggerone and others. 1984. Ocean Discharge Criteria Evaluation: Gulf of Alaska- Cook Inlet OCS Lease Sale 88 and state lease sales located in Cook Inlet. Prepared for the Environmental Protection Agency with Jones & Stokes Associates, Bellevue, WA. 230 p.

Conrad, R.H., and G.T. Ruggerone. 1985. Stock composition of the 1984 sockeye salmon run to the Chignik Lakes estimated using scale patterns and linear discriminant functions. Alaska Dept. Fish and Game Technical Report No. 151. 43 p.

Ruggerone, G.T., and D.E. Rogers. 1986. Chignik Sockeye Studies: Aerial survey of spawning coho salmon along the southern Alaska Peninsula. FRI-UW-8607. University of Washington, Seattle. 40 p.

Ruggerone, G.T., Q. Stober and H. Senn. 1986. An environmental assessment of the resident trout hatchery on the Colville Indian Reservation. Prepared for the Bonneville Power Administration with Jones & Stokes Associates, Bellevue, WA. 59 p. + appendices.

Ruggerone, G.T., B. Smith and S.B. Mathews. 1986. Effects of water flow fluctuations caused by hydropower operations on sport catches of steelhead trout in the Cowlitz River, Washington. Data report prepared for the City of Tacoma.

Van Veldhuizen, H., G.T. Ruggerone and others. 1988. A best professional judgment on Quartz Hill mine tailings disposal in Boca de Quadra, Alaska with reference to Ocean Discharge

Criteria. Final Report. Prepared for the Environmental Protection Agency with Jones & Stokes Associates, Bellevue, WA. 125 pp. + appendices.

Ruggerone, G.T., and D.E. Rogers. 1988. Chignik Sockeye Studies: gastric evacuation rates and daily ration of juvenile coho salmon. FRI-UW-8810. University of Washington, Seattle. 27 p.

Ruggerone, G.T., and D.E. Rogers. 1989. Chignik Sockeye Studies: consumption of sockeye salmon fry by juvenile coho salmon in the Chignik Lakes, Alaska: implications for salmon management.. Ann. Rept. to Nat. Mar. Fish. Serv. FRI-UW-8914. University of Washington, Seattle. 31 p.

Ruggerone, G.T., S.B. Mathews, T. Iverson and R.W. Tyler. 1989. Annotated bibliography: predator control programs and methods for capturing northern squawfish. Pp. 319-354 *in* A.A. Nigro, ed. Developing a predation index and evaluating ways to reduce salmonid losses to predation in the Columbia River Basin. Bonneville Power Administration, Portland, OR.

Mathews, S.B., T. Iverson and R.W. Tyler and G.T. Ruggerone. 1989. Evaluation of harvesting technology for potential northern squawfish commercial fisheries in Columbia River reservoirs. Pp. 278-318 *in* A.A. Nigro, ed. Developing a predation index and evaluating ways to reduce salmonid losses to predation in the Columbia River Basin. Bonneville Power Administration, Portland, OR.

Rogers, D.E., and G.T. Ruggerone. 1989. Bristol Bay salmon forecasts for 1990 and statistics of North American salmon. Annual Report to Pacific Seafood Processors Association. University of Washington, Seattle. 21 p.

Ruggerone, G.T., and R. Denman. 1990. Hydrological characterization of lower Alec River and Black Lake near Chignik, Alaska. Progress report to the Chignik Seiners Association. 10 p.

Alverson, D.L., D.E. Rogers, J.A. Crutchfield, D.W. McNair, J.A. June, J.B. Suomala and G.T. Ruggerone. 1990. Preliminary 1987 Cook Inlet oil spill studies. Prepared with Natural Resources Consultants for Faegre and Benson. 136 p.

June, J.A., G.T. Ruggerone and D.E. Rogers. 1990. Report on the upper Cook Inlet 1987 sockeye salmon season. Prepared with Natural Resources Consultants for Faegre and Benson. 56 p.

Rogers, D.E., and G.T. Ruggerone. 1990. Bristol Bay salmon forecasts for 1991 and statistics of North American salmon. Annual Report to Pacific Seafood Processors Association. University of Washington, Seattle. 21 p.

Rogers, D.E., B. Rogers, G. Ruggerone, D. Helton, L. Patterson and M. Zimmermann. 1990. Alaska salmon research. Annual Report (1989) to Pacific Seafood Processors Association. FRI-UW-9002. University of Washington, Seattle. 27 p.

June, J.A., G.T. Ruggerone and D.E. Rogers. 1991. Report on the upper Cook Inlet 1989 sockeye salmon season. Prepared with Natural Resources Consultants for Faegre and Benson. 97 p.

Rogers, D.E., B. Rogers, G. Ruggerone, L. Patterson and M. Zimmermann. 1991. Alaska salmon research. Annual Report (1990) to Pacific Seafood Processors Association. FRI-UW-9101. University of Washington, Seattle. 31 p.

Ruggerone, G.T. 1991. Evidence for morphological and behavioral responses of juvenile sockeye salmon to size-biased predation. Ann. Rept. to Nat. Mar. Fish. Serv. FRI-UW-9107. University of Washington, Seattle. 18 p.

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Growth and Survival of Salmon in Response to Competition at Sea and Climate Change. State of Salmon 2009 Conference, *Bringing the Future into Focus.* Innovative Approaches to Applying Conservation Principles. February 2-5, 2009. Vancouver, BC

Abundance and relative contribution of hatchery and wild salmon in the North Pacific Ocean. NPAFC International Symposium on the Bering-Aleutian Salmon International Surveys (BASIS): Climate Change, Production Trends, and Carrying Capacity of Pacific Salmon in the Bering Sea and Adjacent Waters. November 23-25, 2008. Seattle, WA, USA

Management Data for Long-term Monitoring of Salmon Growth and Survival versus Climate Change. Long Term Research and Monitoring Project (LRMP), North Pacific Anadromous Fish Commission. April 7-11, 2008. Sokcho, South Korea.

Growth and Survival of Salmon in Response to Competition and Climate Change: Implications for Interactions of Wild and Hatchery Salmon. Symposium: Population Growth, Climate Change and Fish Habitat in the Columbia River Basin. American Fisheries Society Western Division Conference, May 4-9, 2008; Portland, OR.

Climate change, salmon interactions, and implications for salmon recovery. Pacific Salmonid Recovery Conference. November 6-9, 2007. Seattle, WA

Growth and Survival of Salmon in Response to Competition and Climate Change. AYK SSI Symposium on the Sustainability of the AYK Salmon Fisheries. February 6-9, 2007; Anchorage, AK.

Growth and Survival of Salmon in Response to Competition and Climate Change: Implications for Interactions of Wild and Hatchery Salmon. Current Issues Facing Salmon Hatcheries in the Russian Far East. Petropavlovsk-Kamchatsky, Russia. November 30, 2006. Invited by World Wildlife Fund and the Wild Salmon Center.

Growth, Abundance, and Survival of Salmon in Response to Climate Change. World Wildlife Fund, Climate Camp Alaska. Homer, AK. October 30, 2006.

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Survival of Puget Sound chinook salmon in response to climate-induced competition with pink salmon. Lake Washington Salmon Workshop. Seattle, WA. February 2004.

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Survival, growth, and age at maturation of Puget Sound chinook salmon released during odd- versus even-numbered years: evidence for interspecific competition with pink salmon during early marine life. Northwest and Alaska Science Center, NMFS, Seattle, WA. November 2002.

Differential Marine Growth of Sockeye Salmon During Odd and Even Years: Evidence for Density-Dependent Effects of Asian Pink Salmon Abundance on Bristol Bay Sockeye Salmon, 1955-1997. Bristol Bay Salmon Science Symposium, Dillingham, Alaska. May 2001.

Abundance and stock origin of coho salmon on spawning grounds of lower Columbia River tributaries and photographic documentation of habitat disruption. Presentation to Columbia River Coho Salmon Working Group (NMFS, WDFW, ODFW). Portland, OR. February 1999.

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CONFERENCE AND SEMINAR PRESENTATIONS

The salmon MALBEC project: a North Pacific-scale study to support salmon conservation planning. American Fisheries Society North Pacific International Chapter Annual Meeting. Tacoma, WA. June 6-8, 2007. Introduction presented by N. Mantua.

Hatchery Versus Wild Salmon Production in the North Pacific Ocean. American Fisheries Society North Pacific International Chapter Annual Meeting. Tacoma, WA. June 6-8, 2007.

Hatchery Versus Wild Salmon Production in the North Pacific Ocean. 9th Salmon Ocean Ecology Meeting. Newport, OR. March 14-16, 2007.

Ocean Climate Change and Collapse of the World's Largest Sockeye Salmon Population. 9th Salmon Ocean Ecology Meeting. Newport, OR. March 14-16, 2007.

Salmon MALBEC: Model for Assessing Links Between Ecosystems. (N. Taylor- presented). 9th Salmon Ocean Ecology Meeting. Newport, OR. March 14-16, 2007.

Retrospective Analysis of Yukon and Kuskokwim Chinook Salmon Growth. AYK SSI Symposium on the Sustainability of the AYK Salmon Fisheries. Anchorage, AK. February 6-9, 2007.

Growth and survival of salmon in response to climate change, competition, and a dynamic ocean carrying capacity. Global Challenges Facing Oceanography and Limnology. American Society of Limnology and Oceanography, June 2006.

Salmon age structure and variable resilience of Bristol Bay sockeye salmon to climate change. Pacific Salmon Environment and Life History Models: Advancing Science for Sustainable Salmon in the Future. 135th Annual Meeting American Fisheries Society, September 2005.

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Linkages between climate, growth at sea, and abundance of sockeye salmon in Bristol Bay, Alaska, 1955-2000. GLOBEC Symposium: Climate Variability and Sub-Arctic Marine Ecosystems. Victoria, B.C. May 2005.

Survival and Growth of Puget Sound Chinook Salmon in Response to Climate-induced Competition with Pink Salmon: Implications for Habitat Protection and Restoration. Sustainability and Restoration: a practical partnership for the 21st. Society for Ecological Restoration. Seattle, WA. April, 2005.

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Seasonal marine scale growth of Bristol Bay sockeye salmon during odd- and even-numbered years: evidence for competition with Asian pink salmon and seasonal food web dynamics in the North Pacific Ocean and Bering Sea. 5th Annual Salmon Ocean Ecology Meeting. Newport, OR. February, 2003.

Long-term trends in annual Bristol Bay sockeye salmon scale growth at sea in relation to sockeye abundance and environmental trends, 1955-2000. 4th Annual Salmon Ocean Ecology Meeting, 15-16 January, 2002, Santa Cruz, CA.

Differential Marine Growth of Sockeye Salmon During Odd and Even Years: Evidence for Density-Dependent Effects of Pink Salmon Abundance on Nushagak Bay and Chignik Sockeye Salmon, 1955-1997. Pink and Chum Salmon Workshop. University of Washington, Seattle. March 2001.

Natural Habitat Degradation in a Major Salmon Watershed: A Lesson in Salmon Population Resilience and Decline. Washington Lakes Protection Association Conference. SeaTac, WA 2000.

Historical analysis of sockeye salmon growth among populations affected by large escapements associated with the Exxon Valdez oil spill. Legacy of an oil spill: ten years after the Exxon Valdez oil spill. Anchorage, AK. March 1999.

A historical perspective on salmonid production from Pacific rim hatcheries. First Symposium of the North Pacific Anadromous Fish Commission. Hokkaido, Japan. w/ C. Mahnken, NMFS. October 1996.

Factors influencing the survival of salmon in Alaska and the Pacific Northwest. Visitation Retreat & Cultural Center, City of Federal Way, WA. October 1995.

The application of remotely-sensed data to salmon harvest management and operational planning of the salmon industry in Alaska. Third Thematic Conference: Remote Sensing for Marine and Coastal Environments. Seattle, WA. September 1995.

Initial water quality assessment of the Upper Hood Canal Watershed. Presentation to the Upper Hood Canal Watershed Management Committee. Seabeck, WA. November 1994.

Investigations of salmon populations, hydrology, and limnology of the Chignik Lakes, Alaska, during 1993. Chignik Regional Planning Team. Anchorage, Alaska. December 1993.

Population dynamics and winter ecology of sockeye salmon. 1993 Sockeye-Kokanee Workshop. Richmond, British Columbia. March 1993.

Long-term trends in the growth of sockeye salmon from the Chignik Lakes, Alaska. 1993 sockeye-kokanee workshop. Presented by J. Bumgarner. Richmond, British Columbia. March 1993.

Migrations of juvenile sockeye salmon and other fishes into and out of Black Lake, AK. Chignik Regional Aquaculture Association. Everett, WA. December 1992.

Factors affecting the early marine growth of Bristol Bay sockeye salmon. Workshop on the growth, distribution, and mortality of juvenile Pacific salmon in coastal waters. Sidney, British Columbia. October 1992.

Migrations of juvenile sockeye salmon and other fishes into and out of Black Lake, AK. Chignik Regional Planning Team. Anchorage, AK. October 1992.

Sockeye salmon run fluctuations and winter habitat quality of Black Lake, Ak. Chignik Regional Planning Team. Anchorage, AK. April 1992.

Habitat and sockeye salmon dynamics in a unique Alaskan lake. The 54th Annual Meeting of Pacific Fishery Biologists. Semi-am-hoo Resort, Blaine, WA. March 1992.

Responses of juvenile salmon to low oxygen levels in Black Lake during February 1992 and the forecast of adult sockeye returning to Chignik in 1992. Chignik Seiners Association, Shilshole Marina, Seattle, WA. March 1992.

The Alaska Salmon Program of the Fisheries Research Institute, University of Washington. Poster presentation at FISH EXPO 1991. Seattle, WA. October 1991.

Enhancing harvests of Chignik salmon through predator control and habitat rehabilitation: a cost-benefit analysis. Chignik Seiners Association. Seattle, WA. January 1991.

Rehabilitation and enhancement of sockeye salmon returning to Black Lake, Alaska. Chignik Regional Aquaculture Association. Seattle, WA. November 1990.

Factors influencing the large fluctuations of adult sockeye returning to Black Lake, Alaska: results of the 1990 winter investigation. Chignik Seiners Association. Chignik, AK. June 1990.

Bycatch of Pacific salmon by the domestic trawl fishery. The 5th Annual Bristol Bay Fisheries Conference. Dillingham, AK. April 1990.

Salmon projects of the Fisheries Research Institute in Alaska. Annual Meeting of the National Food Processors Association. Seattle, WA. March 1990.

Predator impacts on salmon populations. Annual Meeting of the National Food Processors Association. Seattle, WA. March 1989.

Threespine stickleback (Gasterosteus aculeatus) *aggregations as a refuge from predation for sockeye salmon fry* (Oncorhynchus nerka). National meeting of the Animal Behavior Society. Missoula, MO. August 1988.

Forecasts of Chignik salmon and the effects of predation by coho on sockeye survival in the Chignik Lakes, Alaska. Presentation to the Chignik Seiners Association and salmon processors. Chignik, AK. June 1988.

Salmon forecasts and research activities of the Fisheries Research Institute in the Chignik Lakes, Alaska. Presentation to the Chignik Seiners Association and salmon processors. Chignik, AK. June 1987.

Evaluation of the fisheries monitoring program to determine effects of the proposed Navy Home Port, Everett, WA. Presentation to Engineers and Navy personnel. Federal Way, WA. Oct. 1987.

Salmon forecasts and research activities of the Fisheries Research Institute in the Chignik Lakes, Alaska. Presentation to the Chignik Seiners Association and salmon processors. Chignik, AK. June 1986.

Consumption of migrating juvenile salmonids by gulls foraging below a Columbia River dam. Meeting of the Northwest Chapter, American Fisheries Society. Bellingham, WA. March 1986.

Alaska salmon research by the University of Washington. Seattle Poggie Club. Seattle, WA. April 1986.

Predator-prey interactions of piscivorous coho salmon and juvenile sockeye salmon in the Chignik Lakes, Alaska. Fisheries Research Institute Seminar, University of Washington. October 1986.

Salmon Research in Alaska: Past, Present, and Future. Organized seminar series at Fisheries Research Institute, University of Washington. October- December, 1986.

Salmon forecasts and research activities of the Fisheries Research Institute in the Chignik Lakes, Alaska. Presentation to the Chignik Seiners Association and salmon processors. Chignik, AK. June 1985.

EXPERT WITNESS TESTIMONY

Dam effects on salmon	Reconstructed salmon harvests by Tulalip Tribe had Sultan Diversion Dam not been built in 1916. Estimated fish passage through high gradient cascades. (case mediated & settled, 2005).
Exxon Valdez Oil Spill	Effects of oil spill on salmon tenders in Alaska (deposition, case settled) 2003.
Skokomish Tribe v. Tacoma Power	Tribal harvests had the dams not been built, 1926-1998. Ability of salmon to pass Big Falls prior to inundation by reservoir. (report, deposition, case removed in summary judgment) 2001.
Salmon Forecast Accuracy	Preseason and inseason run size forecast accuracy; insurance claim for 1998 Bristol Bay run failure (report, case settled) 2000.
Calkins v. Burger King	Probability of biotoxin accumulation in pollock from the Bering Sea (report, case settled) 2000-2001.
Proposed Cross Cascade Pipeline	Effects of refined oil pipeline on salmon and habitat (report, deposition, pipeline explosion ended proposed pipeline) 1999.
Dam Effects on Salmon	Chinook and steelhead runs reconstructed to estimate historical (85 yr) runs and harvests had dams not been built. (report, mediation settlement) 1998.
Exxon Valdez Oil Spill	Effects of oil spill on salmon harvests in Alaska (reports, deposition, trial testimony) 1994.
Glacier Bay Oil Spill	Effects of oil spill on salmon harvests in Cook Inlet, Alaska (report, deposition) 1989.
Touchet River Chemical Spill:	Effects of ammonia spill on salmonids in Touchet River, WA (deposition) 1983.

William J. ("Wim") Kimmerer, Ph.D.

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Web:	http://online.sfsu.edu/~kimmerer/	

Current Position

Research Professor, Romberg Tiburon Center for Environmental Studies, San Francisco State University.

Education

University of Hawaii, Ph.D. 1980, Biological Oceanography
U.S. Navy Nuclear Power School, 1968
Purdue University, B.S. 1967, Chemistry

Research and Professional Experience

1994-present	Senior Research Scientist & Research Professor, Romberg Tiburon Center, San Francisco State University
1986-1995	Senior Scientist, BioSystems Analysis Inc.
1982-1985	Research Fellow, University of Melbourne (Australia), Zoology Dept.
1980-1982	Research Associate/Assistant Director, Hawaii Institute of Marine Biology
1976-1980	Research Assistant, University of Hawaii
1973-1980	Graduate student, University of Hawaii
1972-1973	Flight instructor
1967-1972	U.S. Navy submarine force, final rank Lieutenant

Research and Professional Interests

The ecology of estuaries and coastal waters, with emphasis on the San Francisco estuary. I study the influence of the physical environment including freshwater flow, tidal currents, and turbulence on behavior, movement, and population dynamics of plankton and fish; predatory control of species composition and abundance of plankton and fish populations; functioning of ecosystems, populations, and material cycling; and human impacts on aquatic ecosystems and the interaction of science and management. I apply a variety of methods to investigate these processes including laboratory studies, field studies, mechanistic modeling such as particle tracking, individual-based models, and hydrodynamic models, and statistical analyses using traditional as well as modern and Bayesian methods.

Research Projects (San Francisco Estuary)

- Primary production and foodweb dynamics supporting delta smelt
- Population dynamics of copepods and other plankton
- Impacts of changing freshwater flow on the estuarine ecosystem
- Effects of introduced species, particularly introduced clams and copepods
- Effects of water circulation on transport and responses of biota
- Effects of water diversions on populations of delta smelt and salmon and their food
- Potential causes of the recent decline in abundance of several fish species
- Individual-based modeling of delta smelt
- Participant, workshops at National Center for Ecological Analysis and Synthesis on the Pelagic Organism Decline in the San Francisco Estuary
- Environmental controls on Chinook salmon

Management-Related Projects

- Chair, Estuarine Ecology Team, Interagency Ecological Program for the San Francisco Estuary, 1995 – present.
- Co-Chair, Science Board, CALFED Bay-Delta Ecosystem Restoration Program, 2000-2005
- Advisor to the CALFED Lead Scientist on the Environmental Water Account
- Co-convenor, CALFED Ecosystem Restoration Program workshop on adaptive management, 2002
- Co-convenor, CALFED workshops on salmonids and delta smelt, 2001 and 2003, hatchery impacts on Battle Creek, California, 2003, and Environmental Water Account review, 2006.
- Member, Steering Committee and Technical Advisory Committee, Delta Risk Management Strategy (Department of Water Resources)
- Scientific advisory panel, Blue Ribbon Task Force for a Vision for the California Delta
- Review panel, U.S. Fish and Wildlife Service 2008 Biological Opinion on delta smelt.
- Advisory committees, Bay Delta Conservation Plan
- Member, Delta Native Fishes Recovery Team
- Science Advisor, San Francisco Bay Subtidal Habitat Goals Project
- Advisory panel, California Water Resources Control Board hearing on flow standards

Other Professional Activities

- Honorary Fellow, California Academy of Sciences
- Co-founder and former President, California Estuarine Research Society, an affiliate society of the Estuarine Research Federation
- Advisory committee, Georgia Coastal Estuaries LTER Program
- Invited participant in workshops at the University of Rhode Island (effects of freshwater flow on estuaries), Louisiana Universities Marine Consortium (coastal restoration), and the University of British Columbia (science needs for coastal management)
- Associate Editor, San Francisco Estuary and Watershed Science
- Reviewer for professional journals including Limnology and Oceanography, Marine Biology, Marine Ecology Progress Series, Estuaries and Coasts, Estuarine, Coastal, and Shelf Science, ICES Journal of Marine Science, Environmental Biology of Fishes

- Reviewer of grant proposals for the National Science Foundation, EPA, and Seagrant offices, and panelist for NSF
- Chair, Search Committee for Director of the Romberg Tiburon Center, 2008

Selected Publications (last 6 years)

Kimmerer, W.J. 2004. Open-Water Processes of the San Francisco Estuary: from physical forcing to biological responses. San Francisco Estuary and Watershed Science [online serial]. Vol. 2, Issue 1 (February 2004), Article 1. http://repositories.cdlib.org/jmie/sfews/vol2/iss1/art1

Kimmerer, W.J. 2005. Long-term changes in apparent uptake of silica in the San Francisco Estuary. Limnology and Oceanography 50: 793-798

Kimmerer, W.J., M.H. Nicolini, N. Ferm, and C. Peñalva. 2005. Chronic food limitation of egg production in populations of copepods of the genus *Acartia* in the San Francisco Estuary. Estuaries 28: 541–550.

Kimmerer, W.J. 2006. Response of anchovies dampens foodweb responses to an invasive bivalve (*Corbula amurensis*) in the San Francisco Estuary. Marine Ecology Progress Series 324:207-218.

Bouley, P.B. and W.J. Kimmerer. 2006. Ecology of a highly abundant, introduced cyclopoid copepod in a temperate estuary. Marine Ecology Progress Series 324:219-228.

Sommer, T., C. Armor, R. Baxter, R. Breuer, L. Brown, M. Chotkowski, S. Culberson, F. Feyrer, M. Gingras, B. Herbold, W. Kimmerer, A. Mueller-Solger, M. Nobriga, and K. Souza. 2007. The collapse of pelagic fishes in the upper San Francisco Estuary. Fisheries 32(6): 270-277.

Kimmerer, W.J. and M.L. Nobriga. 2008. Investigating dispersal in the Sacramento-San Joaquin Delta using a particle tracking model. San Francisco Estuary and Watershed Science. [online serial]. Vol. 6, Issue 1, Article 4.

Kimmerer, W. 2008. Losses of Sacramento River Chinook salmon and delta smelt to entrainment in water diversions in the Sacramento-San Joaquin Delta. San Francisco Estuary and Watershed Science. [online serial]. Vol. 6, Issue 2, Article 2.

Choi, K-H. and W. Kimmerer. 2008. Mate limitation in an estuarine population of copepods. Limnology and Oceanography 53:1656-1664

Brown, L.R., W.J. Kimmerer, and R.L. Brown. 2008. Managing water to protect fish: a review of California's Environmental Water Account. Environmental Management. 43:357-368.

Choi, K.-H. and W. Kimmerer. 2009. Mating success and its consequences for population growth of an estuarine copepod. Marine Ecology Progress Series 377: 183–191.

Kimmerer, W.J., E.S. Gross, and M.L. MacWilliams. 2009. Is the response of estuarine nekton to freshwater flow in the San Francisco Estuary explained by variation in habitat volume? Estuaries and Coasts 32:375-389.

Grimaldo, L., W. Kimmerer, and A.R. Stewart. 2009. Dietary segregation of pelagic and littoral fish assemblages in a highly modified tidal freshwater estuary. Marine and Coastal Fisheries 1:200-217

Kimmerer, W. J. and A.L. Gould. 2010. A Bayesian approach to estimating copepod development times from stage frequency data. Limnology and Oceanography Methods 8:118-126

Mac Nally, R. and others 2010. An analysis of pelagic species decline in the upper San Francisco Estuary using Multivariate Autoregressive modelling (MAR). Ecol. Appl. 20: 1417-1430.

Thomson, J., W. Kimmerer, L. Brown, K. Newman, R. Mac Nally, W. Bennett, F. Feyrer, and E. Fleishman. 2010. Bayesian change-point analysis of abundance trends for pelagic fishes in the upper San Francisco Estuary. Ecol. Appl. 1431 -1448: 1431 -1448.

Gould, A.L. and W.J. Kimmerer. Growth, reproduction, and development of the cyclopoid copepod *Limnoithona tetraspina* in the San Francisco Estuary. Marine Ecology Progress Series 412:163-177.

Paganini, A., W.J. Kimmerer, and J.H. Stillman. 2010. Metabolic responses to environmental salinity in the invasive clam *Corbula amurensis*. In press, Aquatic Biology.

Kimmerer, W.J. 2010. Modeling delta smelt losses at the south Delta export facilities. In press, San Francisco Estuary and Watershed Science.

Selected Presentations

Kimmerer, W.J. 2008. Water quality and the foodweb of the upper San Francisco Estuary. Invited presentation to the Bay-Delta Public Advisory Committee, January 2008.

Kimmerer, W.J. 2008. Variation of Physical Habitat for Estuarine Fish with Freshwater Flow. Invited, Interagency Ecological Program Annual Meeting, Asilomar, CA, February 2008.

Kimmerer, W.J. 2008. Modeling Approaches for Delta Smelt and Other Fishes in the San Francisco Estuary. Invited presentation to the CALFED Independent Science Board, May 2008.

Kimmerer, W.J. 2008. Structure and Function of the Low-Salinity Zone Foodweb in The San Francisco Estuary. Invited, CALFED Science Conference, Sacramento, October 2008.

Kimmerer, W. 2009. Introduction to Zooplankton Dynamics in Estuaries. Invited introductory talk, Coastal and Estuarine Research Federation, Portland OR, November 2009.

Kimmerer, W. 2010. Effects of climate and other long-term changes on estuaries: a zooplankton perspective. Invited plenary talk, Conference on Climate Change Impacts on Estuarine and Coastal Ecosystems. Boulogne, France.

Kimmerer, W. 2010. The Pelagic Foodweb of the upper San Francisco Estuary: Changing Conditions and Changing Understanding. Delta Science Conference, Sacramento.

Selected Current Funding

U.S. Bureau of Reclamation (Sacramento). Pelagic Organism Decline/Habitat Study Group Investigations. Kimmerer (lead PI) with R. Dugdale, F. Wilkerson, J. Stillman, A. Parker, L. Sullivan, E. Gross, M. MacWilliams.

NSF Biological Oceanography: Feeding and food limitation in copepod nauplii, the neglected life Stage. With S. Cohen, RTC.

CALFED: Foodweb Support for the Threatened Delta Smelt and other Estuarine Species in Suisun Bay and the Western Delta. Kimmerer, lead PI, with R. Dugdale, E. Carpenter, A. Parker (SFSU), R. Cohen (Ga. Southern U.), J. Thompson (USGS), and G. McManus (U. Conn.).

Résumé: Daniel Goodman

Department of Ecology
Montana State University
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Personal History:

Born in Cincinnati, Ohio, May 20, 1945

Education:

Ohio State University, B.Sc. in Biology, Cum Laude, 1966
Ohio State University, Ph.D. in Zoology, 1972

Career History:

1987-present	Professor of Biology, Montana State University
1987-1993	Adjunct Professor of Biology, University of California, San Diego
1981-1987	Associate Professor of Biology, Montana State University
1975-1983	Assistant Professor of Population Biology, Scripps Institution of Oceanography
1972-1974	Research Associate, Program on Science, Technology & Society, and Division of Biological Sciences, Cornell University

Field Projects:

1967	Ecological investigations of ice worms on Casement Glacier, Alaska.
1968	Limnological investigations and reference sample collection on Tower Island in the Galapagos.
1970	Raising a sediment core from the lake Birket Ram, Golan Heights, Israel.

Awards and Honoraries:

Phi Beta Kappa
Woodrow Wilson Fellowship

Committees:

Board of Trustees, The Institute of Ecology 1979-82
Condor Advisory Committee, Cal Fish & Game Commission 1981-85
Committee of Scientific Advisors, US Marine Mammal Comission 1985-89
Scientific Committee, International Whaling Commission 1986-88
Science Advisory Board, US Environmental Protection Agency
Research strategies subcommittee 1987-88
Long-term ecological research subcommittee 1987-1989
Gobal climate research subcommittee 1989
Ecological processes and effects committee 1989-1994
Independent Science Advisory Board for Salmon Recovery, Northwest Power Planning Council 1996-2005
Independent Scientific Review Panel, Northwest Power Planning Council 1997-2005

Scientific Review Panel for Artificial Production, Northwest Power Planning Council 1998-1999
Hawaiian Monk Seal Recovery Team, National Marine Fisheries Service 2002-present
Review Panel for Groundfish Fishery Control Rule North Pacific Fishery Management Council, chair 2002
Science Panel, North Pacific Research Board 2002-2005
Bering Sea Integrated Ecosystem Modelling Oversight Committee, North Pacific Research Board, chair 2006-2010
Fish Passage Center Oversight Committee, Northwest Power Planning Council 2007-present
Validated Sampling Plan Review Panel, Department of Homeland Security 2007-present
Silvery Minnow PVA Working Group, Middle Rio Grande Endangered Species Collaborative, 2008-present
Cook Inlet Beluga Recovery Team, National Marine Fisheries Service 2010-

Current Graduate Courses:

Scientific Method
Introduction to Quantitative Biology
Mathematical Demography and Population Management
Multivariate Analysis of Ecological Data
Parameter Estimation for Ecological Models

Current Graduate Students:

Gina Himes-Boor

Completed PhD dissertations of advisees:

Cullen, J.J.	1980. Chlorophyll maximum layers of the Southern California Bight and mechanisms of their formation and maintenance. University of California, San Diego.
Methot, R.D.	1981. Growth rates and age distributions of larval and juvenile Northern anchovy, Engraulus mordax, with inferences on larval survival. University of California, San Diego.
Dengler, A.T.	1981. Spatial distributions of phytoplankton: limitations of power spectral techniques. University of California, San Diego.
Lopez, G.W.	1981. Population studies on Tisbe cucumaria (Copepoda; Harpacticoida). University of California, San Diego.
Barlow, J.P.	1982. Methods and applications in estimating mortality and other vital rates. University of California, San Diego.
MacCall, A.D.	1983. Population models of habitat selection, with application to the Northern anchovy. University of California, San Diego.

Gustafson, D.L.	1990. Ecology of aquatic insects in the Gallatin River drainage. Montana State University.
Boveng, P.L.	1993. Variability in a crabeater seal population and the marine ecosystem near the antarctic peninsula. Montana State University.
Easter-Pilcher, A.L.	1993. Analysis of the listing of species as endangered or threatened under the Endangered Species Act. Montana State University.
Berkson, J.M.	1996. Modeling the restoration of a metapopulation: Implications for resource management. Montana State University.
Harting, A.L.	2002. Stochastic simulation model for the Hawaiian Monk Seal. Montana State University.
Eguchi, T.	2003. Bayesian mark recapture estimates of population size for the Eastern Bottlenose Dolphin. Montana State University.
Wright, C.K.	2004. Improved wetland detection in Yellowstone National Park by combination of Landsat thematic mapper imagery, image texture, and ancillary GIS information. Montana State University.
Hennen, D.R.	2004. The Steller sea lion (Eumetopias jubatus) decline and the Gulf of Alaska/Bering Sea commercial fishery. Montana State University.
Schwarz, L.K.	2007. Survival rate estimates of Florida manatees (Trichechus manatus latirostris) using carcass recovery data. Montana State University.
Taylor, R.L.	2009. A multistate mark recapture analysis to estimate reproductive rate in the endangered Steller sea lion *Eumatopius jubatus*
Kaeding, L,R.	2010. Assessment of factors that may have affected the cutthroat trout population of Yellowstone Lake during the three recent decades. Montana State University.
Himes Boor, G.K.	2010. Applying novel approaches to old data sets: utilizing opportunistic observations and Bayesian estimation to describe spatial patterns for Steller sea lions. Montana State University.

Completed Masters theses of advisees:

Boveng, P.L.	1985. Effects of nutrient enrichment on Georgetown Lake plant communities. Montana State University.
Wade, P. R.	1987. Distribution and abundance of phytoplankton taxa in the Eastern Scotia Sea. Montana State University.
Adkison, M.D.	1989. Spatial pattern in the influence of sulfur dioxide emissions from Arizona and New Mexico copper smelters. Montana State University.
Ward, E.	2003. Evaluating trends and biases in shipboard tuna vessel data

used in the estimation of dolphin abundance. Montana State University.

Publications and reports:

1970 Ideology and ecological irrationality. BioScience 20: 1247-1252.

1971 (with W.B. Parrish) Ultrastructure of the epidermis of the ice worm, Mesenchytraeus solifugus. J. Morph. 135:71-86.

1971 (with P.A. Colinvaux) Recent silica gel from a saline lake in the Galapagos Islands. Abstr. Ann. Mtng. Am. Soc. Pet. Geol. and Soc. Econ. Paleont. and Miner.

1971 Ecological investigations of ice worms on Casement Glacier, S.E. Alaska. O.S.U. Research Foundation, Institute of Polar Studies, Report No. 39.

1972 The paleoecology of the Tower Island bird colony: a critical examination of diversity-stability theory. Ph.D. Dissertation, Ohio State University.

1973 Standards for occupational exposure to pesticides. In, Report of OSHA Project, College of Adminsitrative Science, Ohio State University.

1974 Natural selection and a cost-ceiling on reproductive effort. Am. Nat. 108:247-268.

1974 The validity of the diversity-stability hypothesis. Proc. First Int. Congr. Ecology. pp. 75-79.

1975 The theory of diversity-stability relationships in ecology Quart. Rev. Biol. 50:237-266.

1976 Ecological expertise. In, H.A. Feiveson, F. Sinden and R.H. Socolow (eds.) Boundaries of Analysis. Ballinger, Cambridge, Mass. pp. 317-360.

1978 (with F.M.H. Reid, E. Stewart, and R.W. Eppley) Spatial distribution of phytoplankton species in chlorophyll maximum layers off Southern California. Limnol. Oceanogr. 23:219-226.

1978 Management implications of the mathematical demography of long lived animals. NTIS (PB-289 678) 80 pp.

1979 (with R.H. Whittaker) The classification of species according to demographic strategy. I. Population fluctuations and environmental heterogeneity. Am. Nat. 113:185-200.

1979 Competitive heirarchies in laboratory Drosophila. Evolution. 33:207-219.

1979 Regulating reproductive effort in a changing environment. Am. Nat. 113:735-748.

1979 Calculating vital rates from spotted porpoise age distributions. NMFS Status of the Porpoise Stocks Workshop, Doc. 51.

1979 On the interpretation of age distributions. IUCN & WWF Workshop on Biology and Management of Northwest Atlantic Harp Seals, Working Paper 7.

1979 Applications of eigenvector analysis in the resolution of spectral pattern in spatial and temporal ecological sequences. In, G.P. Patil and M.L. Rosenzweig (eds.), Contemporary quantitative ecology and related ecometrics. Statistical ecology series. Vol. 12. International Co-operative Publishing House, Fairland, Maryland. pp. 139-155.

1980 Demographic intervention for closely managed populations. In, M. Soule and

B. Wilcox (eds.), Conservation biology. Sinauer, Stamford, Con. pp. 171-195.

1980 The maximum yield problem: distortion in the yield curve due to age structure. Theor. Pop. Biol. 18:160-174.

1980 (with A.M. Barnett, E. Demartini, R. Larsen, P.D. Sertic, and W. Watson). Predicted larval fish losses to San Onofre Nuclear Generating Station Units 1, 2, and 3, and preliminary estimates of the losses in terms of equivalent forage fish. Report to Marine Review Committee of the California Coastal Commission.

1981 Life history analysis of large animals. In, C.W. Fowler and T.D. Smith (eds.) Dynamics of large mammal populations. Wiley-Interscience, New York, pp. 415-436.

1981 The limits to microcosms: problems in the interpretation of toxicity results from laboratory multispecies test systems. Cornell University, EPA Ecotoxicology Workshop, Working Paper.(ERC Report No. 12, May 1982).

1981 Final report of the shadow effects simulation project: depressions of planktonic populations associated with operation of the cooling system of the San Onofre Nuclear Generating Station. Report to the Marine Review Committee, California Coastal Commission.

1982 Optimal life histories, optimal notation, and the value of reproductive value. Am. Nat. 119:803-823.

1982 (with D.P. DeMaster, D.J. Miller, R. DeLong and B. Stewart) Assessment of California Sea Lions/fishery interactions. Proceedings, 47th North American Widlife and Natural Resources Conference. Portland, Oregon.

1982 An assessment of the status of the Northwest Atlantic stocks of hooded seals. Int. Cons. Exp. Mer., Seal Working Group, Working Paper.

1982 Analysis of the harp seal management models. Int. Cons. Exp. Mer., Seal Working Group, Working Paper.

1982 Exploratory analysis of connectivity indices as discriminators of biological oxygen demand. Report to EPA, Environmental Research Laboratories, Duluth.

1982 Dynamic response estimation of population status relative to maximum net productivity level. California Coastal Commission, Ocean Studies Symposium, Proceedings.

1983 Discrete time parametrization of the life history. NMFS, Pre-Status of the Porpoise Stocks Workshop, NOAA.

1983 Converting estimates of fraction pregnant to an estimate of fecundity. Report to NMFS, NOAA.

1983 Multivariate quantitative structure-activity relationships for the prediction of biological oxygen demand in organic compounds. Report to EPA, Environmental Research Laboratory- Duluth.

1983 (with T. Gerrodette and J.P. Barlow) Two computer programs to project populations with time varying vital rates. NOAA Technical Memorandum NMFS-SWFC-28.

1983 Thermal modeling for the Madison River-Ennis Reservoir system: effects of modifications on downstream river temperatures. Report to Blue Ribbons

Area Wide Planning Commission.

1984 Statistics of reproductive rate estimates, and their implications for population projections. Rep. Int. Whal. Commn., Special Issue 6:161-173.

1984 Risk spreading as an adaptive strategy in iteroparous life histories. Theor. Pop. Biol. 25:1-20.

1984 (with R.W. Eppley, and F.M.H. Reid) Summer phytoplankton assemblages and their environmental correlates in the Southern California Bight. J. Mar. Res. 42:1019-1049.

1984 (with R.H. Whittaker and J.W. Morris) Pattern analysis in savannas-woodlands at Nylsvley, South Africa. Mem. Botanical Survey of South Africa. Special Volume 49. 51pp.

1984 Considerations of age structure in back projection calculations for the northern offshore spotted dolphin population. NOAA Admin. Rept. LJ-84-26C.

1984 Uses of the gross annual reproductive rate calculation in the spotted dolphin assessment. NOAA Admin. Rept. LJ-84-22C.

1985 The minimum viable population problem: the demography of chance extinction. NOAA Admin. Rep. NMFS, SWFC LJ-84-44C.

1985 (with T. Gerrodette and J.P. Barlow) Confidence limits for population projections when vital rates vary randomly. Fish. Bull. 83:207-217.

1985 (with P. Smith) Determining a history of fish location with an archival tag: precision of latitudinal estimates using temperature and depth records. In, J.R. Hunter, et al. (eds) The dynamics of tuna movements, an evaluation of past and future research. IATTC. pp 161-178.

1986 (with M. Taper, and S. Hinkins) Geographic patterns in lake chemistry: Analysis of the EPA Eastern Lake Survey. Report to EPA.

1986 (with M. Taper, and S. Hinkins) Comparison of chemical characteristics of lakes that are existing long-term monitoring sites with estimated characteristics of the lake population of the Eastern US. Report to EPA.

1986 (with A.S. Lefohn, and H.M. Benedict) A critique of NCLAN's use of the Weibull curve for predicting crop losses resulting from ozone exposures. Report to API.

1986 (with J.R. Hunter, A.W. Argue, W.H. Bayliffe, A. Dizon, A. Fontaneau, and G.R. Seckel) The dynamics of tuna movements: an evaluation of past and future research. FAO Fisheries Tech. Paper 277.

1987 The demography of chance extinction. In, M.E. Soule (ed) Viable populations. Cambridge U. Press. pp 11-34.

1987 Considerations of stochastic demography in the design and management of reserves. Nat. Res. Model. 1(2): 205-234.

1987 How do any species persist? Lessons for conservation biology. Conservation Biology. 1(1): 59-62.

1987 (with H. Braham). The role of special scientfic permits in relation to the comprehensive assessment. Int. Whal. Commn. Working Paper SC/39/02. 8 pp.

1987 Comments on the sea lion food-habits data: scat contents in the collections from San Clemente Island. NOAA Admin. Rep. LJ-87-07C. 13 pp.

1987 Systematic evaluation of scientific research permit requests: application to the Southern Hemisphere minke whale example. Rep. Int. Whal. Commn. 38:

1987 (with D.G. Chapman). Comments on annex R2 "A preliminary consideration on a method for estimating age-dependent natural mortality from age composition obtained by random sampling." Rep. Int. Whal. Commn. 38:

1988 Dynamic response analysis. I. Qualitative estimation of stock status relative to maximum net productivity level from observed dynamics under harvest. Marine Mammal Sci. 4:183- 195.

1990 Book review–Evolution of life histories of mammals: theory and pattern. Bull. Math. Biol. 52:583-596.

1991 Book review–Matrix models. Bull. Math. Biol.54:149-161.

1992 (with J.H. Jourdonnais, R. Walsh and F. Pickett). Structure and calibration strategy for a water temperature model of the lower Madison River, Montana. Rivers 3:153-169.

1994 (with S. Blacker and J. Clark). Application of data quality objectives to a Hanford waste tank remediation problem. Env. Test. & Anal. 3(4):39-43.

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1994 (with S. Blacker). Application of risk-based decision making for a Superfund cleanup: case study. Env. Sci. & Tech. 28(11):471a-477a.

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M.S., Oregon State University, Fisheries Science, 1994

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Previous Positions:

2000-2001: Instructor in fisheries biology, Oregon State Univ.

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Research Interests and Skills:

Physical-biotic interactions in streams

Fish behavior and life history

Geomorphic influences on aquatic systems

Restoration ecology and philosophy

Social dimensions of natural resource management

Professional Societies:

American Fisheries Society

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Appointments / Honors:

Courtesy Assistant Professor, Department of Fisheries and Wildlife - Oregon State University

Technical Peer Review Committee for Water Temperature Standard Development, USEPA Region 10, 2000-2003

Temperature Technical Advisory Committee, Oregon Dept. of Environmental Quality, 2000-2003

Reviewer for Environmental Management, Regulated Rivers Research and Management, Transactions of the American Fisheries Society, North American Journal of Fisheries Management, Journal of the American Water Resources Association, Fisheries, Canadian Journal of Fisheries and Aquatic Sciences

Selected Publications:

Ebersole, J. L., M. E. Colvin, P. J. Wigington, S. G. Leibowitz, J. P. Baker, M. R. Church, J. E. Compton, B. A. Miller, M. A. Cairns, B. P. Hansen, and H. R. LaVigne. 2009. Modeling stream network-scale variation in coho salmon overwinter survival and smolt size. Transactions of the American Fisheries Society 138:564-580.

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PROFESSIONAL EXPERIENCE:

2001 - present Professor, Louisiana State University
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1998 - 2001 Associate Professor, Louisiana State University
1987 - 1998 Scientist, Oak Ridge National Laboratory
1983 - 1987 Consultant, Martin Marietta Environmental Systems

PROFESSIONAL INTERESTS:

Develop and apply mathematical and simulation models to better understand and forecast the effects of natural and anthropogenic factors on aquatic population populations and communities; use of models in resource management and risk assessment.

TEN EXAMPLE PUBLICATIONS (from a total greater than 120)

Rose, K.A. 2000. Why are quantitative relationships between environmental quality and fish populations so elusive? Ecological Applications 10: 367-385.

Clark, J.S., S. Carpenter, M. Barber, S. Collins, A. Dobson, J. Foley, D. Lodge, M. Pascual, R. Pielke, W. Pizer, C. Pringle, W. Reid, K. Rose, O. Sala, W. Schlesinger, D. Wall, and D. Wear. 2001. Ecological forecasts: an emerging imperative. Science 293: 657-660.

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SYNERGISTIC ACTIVITIES

Fellow, American Associate for the Advancement of Science Associate

Editor, Trans. Am. Fish. Society (1995-97), Ecological Applications (1997-00), Can. J. Fish Aquat. Sciences (08-), Marine and Coastal Fisheries (08-), San Francisco Estuary and Watershed Science (08-).

Member, Reef Fish Stock Assessment Panel, Gulf of Mexico Council, 1998-2006

Member, Independent Science Board of the CALFED Bay Authority (term over)

Member, Review Panel of the CALFED Environmental Water Account (6 years)

Member, Independent review panel of the Long-Term Central Valley Project (CVP) and State Water Project (SWP) Operations Criteria and Plan (OCAP) Biological Opinion on Salmon, January 2009.

Member, Independent review panel of the Long-Term Central Valley Project (CVP) and State Water Project (SWP) Operations Criteria and Plan (OCAP) Biological Opinion on Delta Smelt, Convened by the US Fish and Wildlife Service, November 2008.

Member, Independent review panel of the Delta Risk Management Strategy for the San Francisco Bay ecosystem, 2007-2008.

Member, Review Team of NOAA's Biological Opinion on Endangered Salmon in the San Francisco Estuary, 2005.

Member, Ecosystem Management Science and Statistical Committee for the Gulf of Mexico Fisheries Management Council.

Member, Scientific Steering Committee of the NSF-sponsored Bering Sea Study (BEST) Program.

Member, Scientific Steering Committee of the US GLOBEC Program.

Plenary Speaker, Complex Systems Theory, Post-Modernism, and Science and Scientists in the CALFED Era. 2006 CALFED Science Conference, Sacramento, Oct 2006.

Plenary Speaker, Fisheries Science and Management: New Era of Collaboration or Business as Usual?, American Fisheries Society 133rd Annual Meeting, Quebec City, Aug 2003.

APPENDIX B
Panel Review Questions

June 25, 2010

General Questions for Klamath Review Panels

As part of the Secretarial Determination on the removal of four lower dams on the Klamath River, expert panels will be asked to conduct a scientific assessment. The panels will be asked to determine the most likely effects of the two proposed alternatives on the harvest of selected fish species, mostly salmonids. The two alternatives are:

No Action: No change from current management conditions, which includes ongoing programs under existing laws and authorities that contribute to the continued existence of listed threatened and endangered species and Tribal Trust species. This Alternative would be realized if a negative determination is made. This Alternative is referred to herein as the Current Conditions Alternative (Hamilton et al. 2010).

Proposed Action: Removal of the lower four Klamath River dams and the full range of actions/programs to implement the Klamath Basin Restoration Agreement (KBRA). This Alternative would be realized if a positive determination is made. This Alternative is referred to herein as the Dams-out Alternative.

The products or opinions from the panels will be used by the Economic Sub Team to evaluate the economics of the fisheries. In response to the needs for economic evaluation, the Biological Sub Team included questions of a quantitative nature that would be useful in the evaluation of salmonid fisheries enhancement as required in the Klamath Hydropower Settlement Agreement (KHSA). Inasmuch as the KBRA is part of an alternative under review, we used the broad definition of fish from the KBRA to mean: "the historic complement of species (including races) of fish that naturally occupied the Klamath River Basin". Furthermore, the KBRA defined harvest opportunities to mean: full participation in Tribal, ceremonial, and commercial, ocean-commercial and recreational harvest; and inriver recreational harvest opportunities for anadromous fish species. The time period for the evaluation of the alternatives is 50 years from 2012 to 2062.

We will pose general questions and species-specific questions to the panels. The species specific questions might address a life history attribute or habitat requirement unique to that species. General questions fall into two themes. The first theme examines future habitat conditions and the second theme the viability of fish populations associated with those habitat conditions. Selected questions on habitat address hydrology, water quality, habitat, habitat restoration, ecosystem function, and climate change. The second theme is the biological viability of fish populations as indicated by criteria such as those proposed by Williams et al. (2008): 1) abundance, 2) productivity, 3) diversity, and 4) spatial structure. We propose to use these criteria because they are a conceptually intuitive link to salmonid population size, to the recovery of ESA listed species, and to the potential for harvest resulting in an economic or cultural benefit.

The signatories to the KBRA acknowledged the federal ESA listed status of coho salmon, Lost River and shortnose suckers, and bull trout and the Biological Sub Team recognizes those species have been subject to prior ESA reviews. While the earlier reviews create a data rich record, we encourage the panels to conduct a diligent review of the best available information on each of the species with respect to the two alternatives and the 50 year time horizon which are unique to this review process. Furthermore, we recognize the incongruous nature of the current listing status and the request of projections of future harvest opportunities, but do the best you can.

Ideally, each projection of the fish population abundance, harvestable fraction, and spawning escapement would be provided on an annual basis over the 50 year analytical horizon with some estimate of uncertainty. While such a quantitative estimate may be ideal for economic analysis, the Biological Sub Team and Economics Sub Team recognize projection of fish population abundance may be largely unachievable for most of the species reviewed. Our expectations are that in lieu of quantitative estimates, ranked value of abundance or an expression of change such as “two fold increase” could be used. Also useful is the trajectory of population abundance over time, such as declining or increasing under each of the proposed alternatives. Furthermore, if mileposts along the 50 year timeline marking significant events such as the salmonid populations reaching self-sustaining status, a harvestable surplus, or escapement goals can be identified, then these can be applied to further analysis. Because all ecosystem components can not be quantified, the review panels are encouraged to express qualitative values when predicting quantitative values is not prudent.

Questions:

1) Geomorphology: The two alternatives will result in very different geomorphic dynamics of the Klamath River down stream of Keno Dam. We recognize that the dams are associated with bed starvation of gravels and removal of dams may mobilize sediments over the short-term and over decades. How will alternatives affect geomorphology in the short-term (1-2 years) and over the 50 year period of interest? Included in this question are the potential effects of KBRA restoration activities on geomorphology of tributaries throughout the Klamath Basin and subsequent effects on harvestable populations of fish. What are the expected short-term effects of dam removal on the fish abundance and how long will it take these populations to return to baseline levels?

2) Water quality: The panels will be provided with information on numerous water quality issues from throughout the basin including dissolved oxygen, pH, ammonia, blue green algae, microsystin toxin, phosphorus loading, and Total Maximum Daily Loads (TMDL). Water quality in the Klamath Basin presents a multiplicity of challenges to restoration of fish populations. The Stakeholders and Water Quality Subgroup will provide some insight concerning the likely trends in water quality during the 50 year period of interest. Under these water quality scenerios, how will the two alternatives differ in reaching the goal of harvestable fish populations?

3) Water temperature: If reviewers consider the broad distribution of salmonids, salmonids in the Klamath River Basin are at the southern limit of their range. Furthermore, the removal of dams is predicted to alter the seasonal pattern of water temperatures with higher spring and summer temperatures and cooler fall water temperatures. What are the likely effects of the water temperature regimes under the two alternatives on rearing, spawning, and use of thermal refugia by native salmonids that might be manifest in harvestable fish?

4) Habitat and restoration (KBRA): Habitat is essential to productive fish populations and the stakeholders have recognized this critical linkage in the crafting of the Klamath Basin Restoration Agreement. The review panel will receive information on the use of Ecosystem Diagnosis and Treatment (EDT) method for tributaries above Upper Klamath Lake and the 2-D model of mesohabitats in the project reach to estimate aquatic habitat under the two alternatives. In addition, the panel will be provided a description of KBRA effects on habitat in the Klamath River Basin. The two proposed alternatives will result in different paths and timelines for habitat management. What are the likely effects of the two alternative habitat management paths on the recovery of ESA-listed fish or in the level of harvest of fish populations?

5) Climate change: We recognize a high level of uncertainty is associated with climate change during the 50 year period we are studying for the Secretarial Determination. The review panel will receive information on predicted hydrology and temperature for several climate change scenarios that have been downscaled for the Klamath River Basin. To what extent might potential changes in habitat, the hydrograph, and thermal refugia mitigate the effects of climate change under the two alternatives? What are the likely effects of climate change on the harvest levels of fish under the two alternatives.

6) Abundance: How will the two alternatives affect abundance of the fish population and what are the expectations for the enhancement of the fisheries? This question may have several milestones along a timeline or population trajectory. For example, inasmuch as some fish populations have been extirpated from the upper Klamath Basin for more than 90 years, when might fish be available for tribal ceremonial use within the upper Klamath Basin? Using a time trajectory, when will a sustainable fishery start and at what levels? We recommend the Panel consider abundance at different time scales ranging from seasonal, inter-annual, and to decadal trends. Economic concerns are that extreme variation in fish populations can affect economic stability of fisheries and fishing communities or slow recovery of fish populations and will delay any economic benefits.

7) Productivity: The metrics of productivity of fish populations may be measured several different ways. These methods include: 1) number of recruit spawners produced per parent spawner at low abundance, 2) juvenile outmigrants per adult spawner, or 3) redd counts per redd count of the previous generation. Each of these examples may be expressed through commonly used stock-recruitment models, such as the Beverton-Holt or Ricker curves. We recognize that conditions resulting from the proposed alternatives may not restore fish productivity to levels associated with historical pristine conditions.

What are the most likely expectations for productivity over time and what is the effect of productivity on the number of harvestable fish? (role of hatcheries and productivity?)

8) Diversity: Diversity refers to the variation in phenotypic characteristics such as individual size, fecundity, run timing, and life history patterns of fishes. Collective diversity of groups of subpopulations will reflect the diversity in the selective environments across the range of a fish species. The diversity enables the individuals to respond to changes resulting from subtle to catastrophic events across space and time. For populations lacking diversity the seasonal availability of adult (harvestable) fish to fisheries might result in very short and highly regulated harvest seasons. Historically, diversity of the salmonid populations may have been an important determinant of the seasonal patterns of harvest, the range in size of harvestable adults, and perhaps other characteristics of the fisheries. What will the effect of the two alternatives be on diversity of fish populations? How will the resulting diversity be manifest in the harvestable population of fish? How will potentially low baseline populations and/or introductions of hatchery fish affect diversity under the two alternatives?

9) Spatial structure: Spatial structure of the fish populations refers to the distribution of fish in various habitats used throughout their life history. Spatial structure enables fish populations to respond to localized catastrophic events across the landscape or to long-term changes in the environment. For a fishery, spatial structure of the population may stabilize the opportunity to produce harvestable fish. Will the two alternatives result in improved spatial structure of fish populations and to what extent is that improved structure likely to result in harvestable fish?

10) Ecosystem restoration: Numerous small dams across the U.S. have already been removed and several large dams in the West such as the Elwha Dam (105 ft) and Glines Canyon Dam (210 ft) in Washington State are scheduled for removal in the future. The goals of these dam removal projects range from restoring volitional movement of fish to restoration of entire ecosystems. One of the goals of the KBRA is to restore and maintain ecological functionality and connectivity of historic fish habitats. However, in most drainages, in addition to dams, widespread degradation of habitat and other forms of human perturbations have contributed to the decline of harvestable populations of salmonids. The signatories to the KHSA recognized that dam removal on the Klamath River is perhaps not a panacea for restoration of fisheries, and therefore also proposed the restoration activities of KBRA in an attempt to provide participation in harvest opportunities for fish species. How do the proposed alternatives address ecosystem function and connectivity sufficiently to recover the lost harvest opportunities of fish populations?

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Questions for Expert Panel on Coho Salmon in the Klamath River Basin

The following questions were prepared for the Secretarial Determination to serve as guidance to the expert panel reviewing coho salmon and steelhead of the Klamath River Basin. The questions may be considered along with a set of general questions provided to each of the four panels convened for the Secretarial Determination. The questions are not in order of priority and are not intended to constrain the discussion by the expert panel or limit the final product.

1) Reintroduction and Access to Historical Habitat: Coho historically ranged above Iron Gate Dam (IGD) to at least Spencer Creek and possibly further (Hamilton et al. 2005). Dam removal would result in access to at least 69 miles of currently unused main-stem and tributary habitat. Access to streams above IGD should increase the diversity of habitats available to coho, as habitats in the upper basin are characterized by channels with lower gradients than in the lower basin. Given current and future restored conditions of this new habitat, in conjunction with KBRA actions, to what degree would access to this historical habitat likely affect coho populations? To what degree would access to this historical habitat contribute to the viability of Klamath Basin coho salmon populations?

2) Thermal Refugia: Areas of thermal refugia in the main-stem Klamath River below Iron Gate Dam are limited. Over summering juvenile coho salmon use both these limited main-stem refugial areas and lower portions of tributaries that provide cold-water refuge from critically high main-stem water temperatures (e.g., Belchik 2003; Sutton et al. 2007; Strange 2010; Sutton and Soto 2010). Under the dams out alternative, access will be created to cool water tributaries above the dams in the Project Reach and groundwater areas above the hydropower project (the Wood River, the Williamson River, and springs on the west side of Upper Klamath Lake). This includes a large spring complex discharging directly to the main-stem Klamath River below JC Boyle Dam. This spring complex provides ~225 cubic feet per second of cool water year round (USDI Bureau of Land Management 2003). However, the thermal effects of these springs may be reduced under different flow scenarios (Bartholow and Heasley 2005; Federal Energy Regulatory Commission 2007) and different flow scenarios would result from the dams out alternative. How will increased access to large cool-water areas such as Big Springs in the JC Boyle bypass reach and Project Reach tributaries affect the future viability of the Southern Oregon Northern California Coastal Coho (SONCC) as a population?

3) Phase Shift in Seasonal Temperatures: Under current conditions there has been a phase shift of temperature below the Project of approximately 18 days due to the Project dams. The dams out alternative is expected to return the temperature pattern closer to what naturally occurred prior to dam construction, with warmer spring water temperatures and cooler fall temperatures (Bartholow et al. 2005). This may result in earlier cooling in the fall ranging from about 5° C below Iron Gate Dam to about 1° C

near the ocean (Bartholow et al. 2005) and may be accompanied by earlier spawning of coho salmon in the main-stem Klamath River. How will the two alternatives differ in the effects on seasonal temperature patterns and coho life history strategies over the 50 year period of interest?

4) Climate Change: Climate change may already be affecting the Klamath Basin (Hamilton et al. 2010; draft). Bartholow (2005) found evidence of a 0.5º C increase in water temperatures per decade in the lower Klamath Basin since the early 1960s and suggested the increase may be related to the cyclic Pacific Decadal Oscillation depending on future trends. Downscaled projections from three climate models predict average increases in annual Klamath Basin air temperatures of 2.1 to 3.6º C by 2035-2045 and June-August increases of 2.2 to 4.8º C (Koopman et al. 2009). Snowmelt streamflow timing is likely to be 1-4 weeks earlier across the West (Stewart et al. 2005). Given the presence of large cascade-type springs in the areas above the dams (e.g., J.C. Boyle), that may mediate the warming effects of climate change (Tague et al. 2008; Tague and Grant 2009), how will access to these reaches affect the viability of coho salmon populations? Overall, to what degree do you think the adverse effects of climate change will be mitigated under the two alternatives being considered and what is the likely effect on coho populations?

5) Ecosystem Function: The Klamath Hydropower Settlement Agreement (KHSA) identifies the restoration of salmonid fisheries with a harvestable population as a metric for the two proposed alternatives. Many activities related to habitat restoration under the KBRA are aimed at restoring or increasing harvestable populations of salmonids by restoring a functioning ecosystem, which includes access to suitable habitat for all life stages, productive flow regimes, and improved water quality (e.g., water temperatures and dissolved oxygen). Given the habitat predictions for salmonid populations under the two alternatives, what inferences can be drawn about the likely population response of coho in the 50 year period of interest? Are changes associated with dam removal and implementation of KBRA, which target restoration of salmonid populations and a more functional ecosystem, likely to increase coho populations?

6) Disease Effects to Coho Salmon: In many years, juvenile coho salmon currently suffer high mortality in some portions of the Klamath River below IGD. Ongoing research suggests the relatively high incidence of some diseases are associated with upstream water quality issues, water temperature, spawning aggregations of adult salmon, and/or a lack of flushing flows that would periodically mobilize sediments and attached algae that harbor the disease host (a polychaete) (Federal Energy Regulatory Commission 2007). What are the likely conditions for fish health over the next 50 years under the two alternatives?

7) Migration of Adults and Juvenile Coho: Under current conditions, about 95 percent of the coho salmon spawn in tributaries (Hamilton et al. 2010; draft). However, the main-stem Klamath River is used as an upstream migration corridor for adults, a downstream

migration corridor for juveniles outmigrating to the ocean, as well as rearing habitat for juveniles. Improved flow, water temperature, and water-quality conditions for upstream passage of adult coho may reduce prespawning mortality. Furthermore, desirable conditions during downstream passage and rearing of juvenile coho may be expected to have a positive effect on smolt survival. How would the two alternatives affect habitat connectivity, survival of the various life stages of coho salmon, and the overall populations of coho salmon in the tributaries?

8) Tributary vs. Main-stem Spawning: On the average, about 5 percent of the adult coho returning to the Klamath River (excluding the Trinity River) spawn in the main-stem river. Past surveys indicate that "the proportion of main-stem spawners may be a relatively small percentage of the annual adult coho salmon spawning population" (see p. 8, NMFS 2007 Recovery Plan). Ackerman et al. (2006) describes the approximate 2001 to 2004 run size estimates to various reaches of the Klamath River Basin as being in the low 100s for naturally produced coho. Which of the two proposed alternatives offer the greatest opportunity to increase coho spawning returns in both the main-stem Klamath River and its tributaries?

9) Hatchery Effects: Under conditions without dams, Iron Gate hatchery (IGH) operations will continue for at least eight years following dam removal, assuming that an alternate water supply is secured[i]. Under the Dams-in management scenario, IGH would continue operation for the entire period of analysis (50 years). Under these two alternatives what would be the effects to wild coho populations and harvestable coho populations? Specifically, how might differences in hatchery operations affect coho local adaptation, fecundity, disease vulnerability and genetics under the two alternatives?

10) Uncertainty of Model Predictions: The analyses of the two alternatives for dams on the Klamath River rely to some extent on simulations from several numerical models. Simulations of this type have some uncertainty (see McElhany 2010; NRC 2008, p. 120). The model simulations and outputs imply a level of quantitative information (e.g., certainty, accuracy, precision) for the 50 year period that some interested parties might view with skepticism. The outputs from selected models include temperature (Bartholow 2005, Bartholow et al. 2005; Flint and Flint 2008), hydrology (Grieman 2010), climate change (Grieman 2010), sediment movement (Stillwater Sciences 2008; 2009) and the coho salmon life-cycle predictions (Cramer Fish Sciences 2008). To capture variability in predicted climate change, multiple models were used and for other modeling some processes may have been represented as stochastic. Please describe your assessment of the uncertainty associated with each of the alternatives relative to the long-term viability of coho populations in the Klamath River Basin.

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[i] As outlined in Interim Measure 19: Hatchery Production Continuity in the KHSA. A post-Iron Gate Dam Mitigation Hatchery Plan must be submitted 6 months following an Affirmative Determination incorporating the results of a study on the viability of Iron Gate Hatchery following dam removal. This study has not yet been conducted and the plan has not yet been developed.

Questions for Review Panel on Steelhead in the Klamath River Basin

The following questions were prepared for the Secretarial Determination to serve as guidance to the expert panel reviewing steelhead of the Klamath River Basin. The questions may be considered along with a set of general questions provided to each of the four expert panels convened for the Secretarial Determination. The questions are not in order of priority and are not intended to constrain the discussion by the expert panel or limit the final product.

1) Reintroduction and Access to Historical Habitat: Steelhead ranged historically to tributaries above Iron Gate Dam (IGD). Dam removal would result in access to more than 350 miles of currently unused habitat, yet the increase in numbers of steelhead expected from this access is modest (Fortune et al. 1966; Chapman 1981; Huntington 2004).

    a. Management agencies have proposed a passive reintroduction plan for the recolonization of habitat unavailable to anadromous fish for nearly 100 years. Have *O. mykiss* populations currently upstream of the dams retained the potential for an anadromous life history?
    b. Given passive reintroduction and future habitat conditions with Dams out with the Klamath Basin Restoration Agreement (KBRA), to what degree would access to this historical habitat likely contribute to sustaining or expanding steelhead populations?
    c. How would these potential returns of steelhead compare to present returns to Iron Gate Hatchery?

2) Thermal Refugia: Juvenile steelhead tend to use thermal refugia in the main-stem Klamath River to a greater extent than juvenile coho salmon (Sutton et al. 2004). Under the dams out alternative, temperatures below IGD will be warmer in spring and early summer. This may result in refugia areas being diminished and used for longer periods of time during this period. At the same time, access will be created to cool water tributaries above the dams in the Project Reach and groundwater areas above the hydropower project (the Wood River, the Williamson River and springs on the west side of Upper Klamath Lake). This includes a large spring complex discharging directly to the mainstem Klamath River below JC Boyle Dam. This spring complex provides ~225 cubic feet per second of cool water year round (USDI Bureau of Land Management 2003). However, the thermal effects of these springs may be reduced under different flow scenarios (Bartholow and Heasley 2005; Federal Energy Regulatory Commission 2007) and different flow scenarios would result from the dams out alternative. To what degree will upstream thermal refugia benefit steelhead in the basin?

3) Phase Shift in Seasonal Temperatures: The dams out alternative is expected to result in a phase shift of seasonal temperatures of about 18 days under some predictions (Bartholow et al. 2005), reverting back to natural thermographs prior to dam construction. This should result in earlier cooling in the fall accompanied by earlier warming in the spring and therefore earlier spawning of steelhead in the mainstem Klamath River. How will the two alternatives differ in the effect on seasonal temperature regime timing and what are the expected effects on steelhead populations over the 50-year period of interest?

4) Climate Change: Climate change will bring higher water temperatures and greater risk of fish health problems. However, steelhead tolerate higher water temperatures than coho salmon. Juvenile steelhead can live in streams that regularly exceed 24°C for a few hours each day with certain food availability and temperature ranges (Moyle 2002). How will the two alternatives affect steelhead in the Klamath River?

5) Short -Term Effects of Dam Removal Downstream from IGD: Overall, anadromous fish populations are predicted to be highly sensitive to the short term impacts of sediment released following the proposed removal of the four dams in 2020 (Federal Energy Regulatory Commission 2007). Steelhead life history characteristics; however, should allow a strong recovery (Stillwater Sciences 2009). How long would it take for recovery of main-stem steelhead populations below IGD following dam removal? How might this affect low populations of summer steelhead?

6) Expansion of Recreational Fishery: There are opportunities to increase recreational fishing for steelhead under both management scenarios. Which of the two management options has the greatest likelihood of expanding fishing locations and the length of seasons for steelhead? Above IGD, where would fisheries for steelhead be most likely to develop?

7) KBRA Habitat Restoration: Steelhead largely spawn and rear in tributaries. Many of these have been impacted by water diversion and habitat degradation. Proposed projects in the KBRA include: 1) restoring floodplain connectivity in mid-Klamath tributaries, 2) modifying barriers at tributary outlets, 3) improving fish passage at culverts, 4) adding large wood structure, 5) improving water quality (e.g., dissolved oxygen, water temperatures, and presence of cyanobacteria toxins), and other restoration actions (Barry et al. 2010; Stillwater Sciences 2010). How will the two alternatives differ in the effects on productivity, capacity, and habitat connectivity for steelhead?

8) Drought Conditions: The panel will be presented an update on the current knowledge of drought conditions and how proposed management addresses those conditions. Would the two alternatives have different effects on the frequency, magnitude, and duration of low flows? If so, what are the likely effects of the differing low flow regimes on populations of steelhead?

9) Ecosystem Function and Riverine Processes: Impoundments and water withdrawals can change the riverine processes downstream. These effects can include bed starvation of gravels, diminished flood flows and creation of incised channels. A recent review has suggested returning impounded and highly regulated rivers to a more normative state, but not a pristine natural state, is an alternative that will provide ecosystem services (Williams 2006). For example, in the Grand Canyon, flushing flows have been used to restore riverine processes (Gloss et al. 2005). Which of the two alternatives will provide the most opportunities to provide a normative Klamath River and what will be the likely effects on the steelhead populations?

10) Fish Disease: What are the expected effects, both short and long term, of dam removal and implementation of KBRA on fish disease (other than *C. shasta*) and what affect might it have on steelhead populations?

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APPENDIX C
Comments and Responses on the Draft Report

Note: In the following text, the major peer review points were responded to by the Panel. The responses are indicated in **bold font** indented below the main comment.

Review of:

Klamath River Expert Panel Draft Report
Scientific Assessment of Two Dam Removal Alternatives on Coho Salmon and Steelhead

Summary of Comments Received from Peer Reviewers and Expert Panel Responses

General Comments Received from Peer Reviewers:

The reviewers of the subject draft panel report are exceptionally well qualified to evaluate the report and to provide recommendations for its improvement. Both reviewers hold Ph.D. degrees and are currently teaching at major universities in the western United States. They have conducted extensive research related to riverine ecology, including the ecology of salmonids and the influence of habitat alterations on their populations. Between them, they have over 50 years of scientific research experience. In addition to having published several hundred peer reviewed articles in scientific journals, they have written over a dozen books and monographs on fisheries science and conservation biology. Both individuals have international scientific research experience. The senior reviewer has been and is currently an advisor for major national and international, governmental and academic research studies related to freshwater biodiversity throughout the world.

Both reviewers expressed disappointment with the quality and content of the draft report. This disappointment resulted more from the process of its preparation rather than the work of the expert panel. Both agreed that the authors of the report did the best job possible given the limited time and information that they were provided. One of the reviewers commented that the answers to the questions posed to the panel and the analysis of the overall Klamath Basin situation to be based on "solid science and ecology." However, the other reviewer suggested that the report not receive wide distribution due to its inherent limitations resulting from the lack of key information that should have been provided to the panel.

Importantly, the reviewers encourage the U.S. Fish and Wildlife Service and cooperating agencies to embrace the six recommendations of the panel for improving the overall process of evaluating the impacts of the two dam removal alternatives. Those recommendations are:

1. Develop an overall conceptual model,
2. Form a centralized science advisory group with strong leadership,

3. Form adaptive monitoring and research plans based on the overall conceptual model of the system,
4. Provide the specific details of the of the KBRA actions and how they will be implemented,
5. Accomplish additional temperature analyses and the modeling to characterize within-day variability and
6. Develop and use stage specific and life cycle models of growth, mortality, reproduction, and movement of both species.

Recommendations offered to improve the report include providing the reader more background on the history and issues related to the management of dams in the Klamath Basin and to describe the proposed actions to be undertaken within the Klamath Basin Restoration Agreement (KBRA). Having this information is a key to understanding and evaluating the possible impacts to the species. As additional background, information on the key limiting factors to coho salmon and steelhead abundance in the Klamath Basin could be provided.

It was further recommended that the conclusions of the authors be presented in a single section of the report. The conclusions could then be grouped according to the panel's level of confidence in them. For example the panel's conclusions could be separated into those about which they are highly confident, somewhat confident, or those that they believe are highly speculative. It is also suggested that the Table in the Executive Summary be expanded to identify why conditions will be different without dams and with the KBRA.

A reviewer questioned the lack of information in the report related to "chemical contaminants, effects of dam removals on foods and food webs, and future land uses." He also suggested that the topic of climate change and its affect on the restoration efforts also be considered.

Specific page and sentence related recommendations can be found imbedded in the verbatim reviewer comments below.

Comments Received from Peer Reviewers and Expert Panel Responses:

Reviewer 1

1. The panel members are well-regarded as outstanding scientists. If the necessary information had been provided to them, a much more thoughtful, coherent and comprehensive report would have been forthcoming – even with a short 5 days to do the job. Basically, preparation of the report must have been a deeply frustrating exercise for the Expert Panel. The lack of so much key information (e.g., life history model), the vagueness of specific actions to be undertaken within the Klamath Basin Restoration Agreement (KBRA), not being provided an overall initial synthesis of existing information, and an apparent lack of scientific leadership by the U.S. Fish and Wildlife Service to provide timely and thoughtful information for the review clearly hampered their ability to adequately evaluate how dam removals could impact coho and steelhead in the coming decade(s). It was also quite frustrating reading report for these very reasons.

a. **This comment is noted.**

2. All in all, this is a poor start for a long term process for the Klamath Basin. This is especially so when there is so much potential to restore anadromous fishes and environmental quality in the Basin. The U.S. Fish and Wildlife Service, and other associated agencies, should be embarrassed (and perhaps ashamed) of their lack of professional performance leading up to the Expert Panel meeting. I completely agree with the Panel's statement in the Executive Summary that their [the Panel's] "… statements are no substitute for further scientific investigation". That said, it seems that the Expert Panel did as well as they could possibly do under the circumstances.

    a. **This comment is noted.**

General Comments on the Report

3. There are several important questions and issues that are not adequately addressed in the Report. I realize that these may not be answerable by the Panel given the lack of information provided. However, a few well-crafted sentences could improve the readability. Consider the following:

    What are the key factors limiting or controlling coho/steelhead abundance in the Basin? Assuming that they can be identified, how are they spatially distributed and when are they most limiting relative to specific life history stages? Even if the limiting factors cannot be identified with precision, there should be a paragraph or two in the Introduction giving a broad overview or outlining the key aspects to be quantified.

    a. **The Panel has revised the text of the report in an attempt to improve overall readability and more clearly discuss the key factors. The Executive Summary provides the reader with a concise discussion of the Panel's findings. The body of the report includes discussions regarding key limiting factors, including where in the Klamath River Basin they are experienced under both alternatives, and which life history stages they are most limiting for both species based on the information provided.**

4. The Executive Summary would benefit by having a brief description of the proposed actions to be taken under the KBRA, even in general terms. As a reader who is somewhat new to the Klamath Basin, I would have welcomed a short synopsis of the dams to be removed (actions to be taken), the reasons for doing so, the key issues associated with dam removal, the hoped for outcomes, and the possible duration of the project.

a. **The suggestion to include a short synopsis is noted. However, in an effort to retain the succinct format of the Executive Summary, the Panel has elected to not include the short synopsis. A discussion of the suggested items is provided in the body of the report. The body of the report provides the reader with tables summarizing the general actions targeted under KBRA, as well as a description of the reasons for removing the dams, the key issues associated with dam removal, the hoped outcomes, and the overall duration of the process.**

5. The Report could use a section stating the conclusions that the Panel feels highly confident about, which ones they feel reasonably confident about, and which ones are highly speculative. This section could be presented in a manner similar to recent IPCC reports. This would give readers a better sense of what conclusions are based on sound evidence and which ones are based on extrapolation from other sources or situations. This is done to some extent in the Executive Summary where the Panel identifies six principal obstacles to drawing convincing conclusions. In order to balance this approach, it will be important to indentify where convincing conclusions can be drawn with existing information, even if they are rare.

a. **The suggestion to include a section re-stating the conclusions, and qualifying the conclusions with confidence statements, is appreciated and noted. The Panel has provided extensive text throughout the report about the confidence of their answers to the questions put to them, and has elected to not include such a section that re-states and qualifies each conclusion, as suggested by this commenter. Section 4.3 of the final report provides a discussion of the Panel's caveats and recommendations.**

6. The Table in the Executive Summary is useful but it does not go far enough in identifying why conditions without dams and with KBRA will be different. Often this can be done with a sentence or phrase, and would improve understanding among the readers. For example, say why temperature regimes will change (i.e., identify possible mechanisms). Perhaps consider adding a fourth column that does this?

a. **The Panel has elected to remove the Table (ES-1) in the Executive Summary for clarification and in response to this and other comments.**

7. Several topics of basic importance are largely missing from the report. Most notably, these are chemical contaminants, effects of dam removals on foods and food webs, and future land uses. I found this especially puzzling since these topics are so closely tied to sediment properties and regimes, and changing sediment fluxes and properties are fundamental considerations associated with dam removals. Even if the issues cannot be addressed in detail, they should be prominently mentioned as topics for future research and monitoring.

a. **The Panel was not specifically tasked to evaluate chemical contaminants, effects of dam removals on food and food webs, and future land uses. The Panel's task was to answer the questions put to them, to the extent that the Panel could given the information provided.**

8. The use of Environmental Flows for restoration is receiving a lot of attention in the literature[1]. The Panel might consider looking at this approach to see if it would be appropriate for the Klamath Basin and for coho/steelhead in particular.

   a. **This comment is noted.**

9. With the time available to the Panel it was not possible to adequately consider the consequences of climate change (or environmental change) on coho and steelhead. Nevertheless, investigating this further should be a key recommendation. Many restoration actions fail because they do not adequately account for future conditions[2], and environmental conditions are changing rapidly in the Klamath. The Panel could do a great service by suggesting a way forward on this topic.

   a. **The effects of climate change are addressed in the report with respect to the questions put to the Panel regarding this subject.**

10. Since the Panel had neither the time nor the resources to examine original data or re-do analyses, and because severe limitations the technical information supplied to them, I suggest that this report receive a very limited distribution. My fear is that it will be used to justify actions because of the quality of the Panel assembled. The Panel has clearly stated that much of what they have concluded should be considered as hypotheses – and I hope this will be readily understood and appreciated by decision makers.

    a. **This comment is noted.**

Specific Comments

11. P. 17: The statement "The questions posed to the Panel are not answerable with a satisfactory degree of precision or confidence" should be in bold letters. Other sentences similar to this one are found throughout the report and should be (at least) in italics.

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[1] Arthington, A.H., R.J. Naiman, M.E. McClain and C. Nilsson. 2010. Preserving the biodiversity and ecological services of rivers: New challenges and research opportunities. Freshwater Biology 55:1-16.

Poff N. L., B. D. Richter, A. H. Arthington, S.E. Bunn, R. J. Naiman, E. Kendy, M. Acreman, C. Apse, B.P. Bledsoe, M. C. Freeman, J. Henriksen, R. B. Jacobson, J. G. Kennen, D. M. Merritt, J. H. O'Keeffe, J. D. Olden, K. Rogers, R. E. Tharme and A Warner. 2010. The ecological limits of hydrologic alteration (ELOHA): a new framework for developing regional environmental flow standards. Freshwater Biology 55:147-170.

[2] Bernhardt E.S., Palmer M.A., Allan J.D. et al. (2005). Synthesizing U.S. river restoration efforts. Science 308: 636–637.

a. **This comment is noted. The Panel has revised these statements in the report.**

12. P. 20: The topic of scientific leadership should be highlighted in some way.

    a. **This comment is noted. The Panel has elected to not highlight this topic.**

13. P. 37: The rationale for acquiring data on within-day temperatures was not evident in the Executive Summary. It is clearly explained here but needs to be simply explained in the Executive Summary too.

    a. **This comment is noted. The Panel has elected to retain the discussions regarding acquiring data on within-day temperatures in the body of the report.**

14. "Water Quality" and several other important terms are never defined. A short glossary of key terms would be helpful.

    a. **This comment is noted. The Panel has elected to not include a short glossary of terms in the report. Selected terms and statements in the report are afforded additional discussion for clarification.**

15. P. 42 and elsewhere: It may be important to place more emphasis on the use of bioenergetic models to better understand the consequences of dam removals. A few sentences explaining how they could be used may act as a catalyst for future investigations.

    a. **This comment is noted.**

Reviewer 2

1. I have read and reviewed the draft report of the Klamath River Expert Panel's Scientific Assessment of Two Dam Removal Alternatives on Coho Salmon and Steelhead by Dunne et al. January 8, 2011. My main impression after carefully reading this document is that of disappointment. Yet, the disappointment does not arise with the report itself, but rather with the scientific oversight and rigor that has been applied to the entire process. In fact, I found the experts (Dunne et al.) to be more than qualified and the panel's report to be clear, concise and accurate and I strongly agree with their main conclusions as I will detail below.

    a. **This comment is noted.**

2. But before that I want to highlight three of the largest and most troubling aspects that Dunne et al. emphasize in their report that are germane to the entire endeavor, namely the lack of specificity of the KBRA activities, the lack of a clear overall conceptual model for the system and the lack of actual and appropriate peer review on sections of the work

leading to this report. Each of these three things in and of themselves is troubling both scientifically and managerially but when all three of them are combined in one large and potentially controversial research plan, it begins to be very worrisome. For example, the KBRA activities sound like well meaning, science-influenced options, but their extreme lack of specificity, which is only partially supported by quantitative data, makes the whole exercise sound like a set of 'just-so' or 'wishful thinking' goals. As an ecologist myself who has made a career out of employing and having faith in the efficacy of the scientific method, these types of unspecified and vague (but well meaning) restoration goals should really be a thing of the past. Restoration has come a long way towards a rigorous science in the past 20 years and vague plans such as these are not appropriate to a project of this scale and magnitude, nor one that has the potential for such controversy. Before this proceeds, I would strongly urge that the KBRA activities be made scientifically specific and concise within the bounds of the available data.

a. **This comment is noted.**

3. In addition, the development of an overall conceptual model for the system would go a long way in helping address the deficiencies with the KBRA activities. As Dunne et al. suggest, developing such a model will act to not only focus and sharpen thinking on the system, but it will allow for a form of adaptive management to be built into the plan from the beginning. With a program of this size, complexity and with so many unknowable variables at the outset, the only logical approach for some measure of long term success is to build into the project the ability to generate and test predictions and then revise managerial or operational options based on the results (i.e. a form of adaptive management). The most reasonable way to do this effectively is to have a detailed conceptual model of the system from which to make hypotheses and predictions and I strongly urge that this happens.

   a. **This comment is noted.**

4. The difficulties that Dunne et al. mention with respect to rigorous peer review are extremely troubling but can be dealt with fairly easily. First I would have a clear definition of what is meant by peer review that all parties involved fully understand. Secondly I would make the peer review process as transparent as possible by making available both the reviews themselves and the response(s) to the reviews and then provide documentation of the subsequent changes that are implemented as a result of the reviews. All of this needs to be made clear and follow a standard protocol, to insure and protect the integrity of the process.

   a. **This comment is noted.**

5. In terms of the main report, the primary question to be answered by the panel is whether either of the two options (option 1 = conditions with dams and option 2 = conditions without dams and KBRA) will positively influence the populations of coho or steelhead. As a fish ecologist I feel that a large portion of this answer depends on three of the potential aspects of option 2, namely: whether the fishes will likely spawn in the opened

main-stem habitat, whether increased access to currently unavailable habitat will occur and whether there will be increased thermal refugia under the plan.

a. **This comment is noted.**

6. According to the information provided to Dunne et al. it seems likely that potential spawning in the main-stem could increase slightly under option 2. Unfortunately this is not a preferred spawning location for either of these species, so the potential benefits are therefore limited. In addition, any benefit will also somewhat depend on how the KBRA activities are specifically defined, and as mentioned above, since these are vague at best, it is hard to predict much of an increase under option 2.

a. **This comment is noted.**

7. As to the question of whether option 2 will produce increased access to additional habitat, again the answers are not clear. It seems that steelhead would likely fare much better than would coho, due to their inherent ability to ascend farther upstream, yet the specific responses of either species is murky at best. If fish can successfully pass through the two lakes (Keno and Upper Klamath Lake) then it looks possible for steelhead populations to have access to more habitat with option 2, as coho are not likely to successfully pass through these barriers. The response for steelhead could be significant but it is not a sure thing.

a. **This comment is noted.**

8. Finally in terms of the question about increased thermal refugia and temperature issues under option 2, the potential results are again mixed. It may be that option 2 and the KBRA activities will act to increase the amount of cool temperature habitat after August and if fish make it past Keno and Upper Klamath Lake there is the possibility that they will have access to additional cool water areas. But at the same time, option 2 and KBRA will likely make the main-stem water warmer before August and the potential for upstream refugia is largely limited to steelhead. In addition, it’s not clear how each of these effects will impact the various life stages of the fishes, partly due to the lack of a comprehensive conceptual model of the system or models for each of the species.

a. **This comment is noted.**

9. I feel strongly that Dunne et al. have done a very good job interpreting the data presented to them in the extremely short time window (5 days) and have more than adequately described the difficulties and challenges involved in determining their answers to the set of questions posed to them. I find that their answers and analysis of the situation are both grounded in solid science and ecology. Given Dunne et al.’s thorough interpretation of the data and synthesis of the information presented to them, I feel that despite the flaws and difficulties with this proposal that it still makes reasonable sense to go ahead with option 2 (conditions without dams and KBRA). I also heartily encourage the acceptance of the following specific recommendations from Dunne et al.’s report:

1. Development of an overall conceptual model,
2. Form a centralized science advisory group with strong leadership
3. Formation of adaptive monitoring and research plans based on the overall conceptual model of the system
4. The need for specification of the details of the KBRA actions and how they will be implemented
5. The need for additional temperature analyses and modeling to characterize within-day variability
6. Development and use of stage specific and life cycle model models of growth, mortality, reproduction, and movement for both species.

a. **This comment is noted.**

10. I look forward to seeing how this process plays out in the future as this is a groundbreaking opportunity and I strongly urge that the main findings and suggestions of Dunne et al. be incorporated into future portions of this plan.

a. **This comment is noted.**

April 25, 2011

Klamath River Expert Panel
Scientific Assessment of Two Dam Removal Alternatives on Coho Salmon and Steelhead
Response to Comments on the Draft Report dated January 8, 2011

Comment Number	Comment Author	Page, Paragraph	Comment	Panel Response
1	K. Cummins	(none provided)	The panel concluded that available information is insufficient to determine the net effects of dam removal on disease incidence, and that studies and pilot manipulations could reduce the large uncertainty surrounding this issue. I agree wholeheartedly on the need for further research, some of which is already underway, for the disease dynamics are very complex. The polychaete host of the myxozoan parasites in particular is very difficult to study. With a nearly microscopic body size (maximum length of 4mm) and spatially and temporally patchy distribution in a large river system, the analogy of looking for a needle in a haystack is apt. However, I maintain that pilot studies already completed coupled with field data collected by my group and others point toward the very large role played by streamflow in maintaining populations of the polychaete in the mainstem of the Klamath, and believe it is very likely that scouring flows would be highly effective in reducing polychaete populations. For example, Stocking (2006) reported the highest polychaete density described to date (over 40,000 individuals per square meter) from the Tree of Heaven location below Iron Gate Dam in March 2005. After a high flow event in May-June 2005, the location was sampled again and no individuals were found. A reference population upstream, that had not been impacted by the high flow, maintained similar numbers before- and after. In laboratory studies to rear the polychaete (Willson, S.J., M.A.	The Panel could only go on what information was available. The Panel responds that remarkably, very little of the extensive literature on disease dynamics was actually provided to the panel, and this topic required a lot of literature-digging, benefiting from the generous response of Jerri Bartholomew. The fact that further research is now underway on the very topic of flow and sediment effects on polychaetes supports the Panel's conclusion that research is needed to better understand and predict the likely effects of dam removal on polychaete distributions and therefore disease dynamics.

Comment Number	Comment Author	Page, Paragraph	Comment	Panel Response
			Wilzbach, D.M. Malakauskas, and K.W. Cummins 2010. Lab rearing of a freshwater polychaete Manayunkia speciosa, Sabellidae) host for salmon pathogens. Northwest Science, Vol. 84: 183-191), we found that polychaetes were easily displaced by increasing current velocity. We are in the process of conducting experimental flume studies, funded by PacifiCorps, to evaluate the effects of varying velocities and particle sizes of transported sediments on viability and displacement of the polychaete. Unfortunately the data are not yet in hand, and scientific research doesn't always keep pace with the need for real world decisions.	
2	K. Cummins	(none provided)	How does this relate to removing the dams? High flow, scouring events could of course be artificially created by spilling water over the dams, and downstream polychaete populations could be reduced by flow management with the dams still in place. However, the reduction in polychaete abundance would likely only be temporary. We have found that the most reliable year-round location for collecting polychaetes is in the upper river, above the dams, where populations are maintained in a eutrophic and stable flow environment. As long as the dams are kept in place, upstream populations will continue to serve as a reservoir to continually replenish depleted populations downstream. If the dam system is removed, however, the upstream reservoir can be flushed out and a reduction in polychaete abundance is more likely to be sustained.	This comment is noted. The Panel agrees that the dams-in scenario will continue to provide for poor conditions. Whether the information on the dams-out scenario is sufficient to conclude that dams-out will alleviate the problem sufficiently (i.e., reduce polycheates) to benefit coho remains speculative.
3	K. Cummins	(none provided)	In sum, I support removal of the dams as the most promising way to disrupt the disease dynamics, by ensuring a long term reduction in polychaete populations. I also strongly recommend that data continue to be collected before- during- and following-dam removal, so that we are always in a position to increase our	This comment is noted. See response to comment 2.

Comment Number	Comment Author	Page, Paragraph	Comment	Panel Response
			understanding of effective river management. Taking out dams should never provide a license to stop conducting research, but neither should a need for more data stand in the way of a need to act based on the best available information at hand.	
4	PacifiCorp	I, last paragraph	Some EDT modeling information on steelhead performance under dams out alternative (see Option 5) can be found in the FERC record. The file (Response to November 2010 2005 FERC AIR-2) was sent to the Chinook expert panel on Jan-13-2010. The limitations of the data and analysis are made clear in the report, but the model runs are based on habitat data collected and entered into the model by local biologists. Because habitat data for all reaches have been entered into the EDT database, coho analyses could be readily completed if needed. <u>Citation</u>: Response to November 10, 2005, FERC AIR AR-2 Ecosystem Diagnosis and Treatment (EDT) Analysis PacifiCorp, Portland, Oregon.	This comment is noted. The Panel was instructed during its deliberations to not consider the EDT analysis.
5	PacifiCorp	“ii”, Number (1)	The authors may want to consider including lack of water quality improvement over the first ten years as an additional reason benefits to both species may be small.	This comment is noted.
6	PacifiCorp	Table ES-1, Recreational Fishery	It is our understanding that Trinity River hatchery will continue to function under both alternatives. Iron Gate hatchery production (or production at a similar level from other facilities if Iron Gate hatchery is no longer able to function following Iron Gate removal) will be eliminated 8-years after dam removal. This assumption should be confirmed before submitting the final report. Total coho adult returns to Iron Gate Hatchery have averaged	The Panel responds that we did check on hatchery removal with John Hamilton and used information provided by him, although there seemed to be uncertainty in what would actually happen with the Iron Gate Hatchery.

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			~1,300 since 1993. These data should be incorporated into the analysis when stating differences in coho production for each alternative.	
7	PacifiCorp	Pg 35; 1st paragraph	The authors imply that the transport capacity of the river may move any gravel placed in the newly exposed habitat under the reservoir downstream and out of the area. However, they then suggest that gravel placement might be considered in the JC Boyle reach as it naturally receives little sediment. But given that the transport capacity of the river is likely similar at both locations would this action be effective?	The Panel was told of plans to augment gravel supplies to the project reach. It is taken for granted that any gravel supplied to the reach, naturally or artificially, will eventually be swept downstream. However, if the agencies insist on augmenting gravel supplies to the project reach, choosing low-gradient reaches will increase the residence time of the gravel bars produced. The Panel is not suggesting that the idea of gravel augmentation is worthwhile, but the Panel was told that there was considerable enthusiasm for such activities, and that some sporadic gravel augmentation is already underway.
8	PacifiCorp	Pg 37; section 3.4 Water Quality; Conditions without dams and with KBRA	The authors should be more specific about the time frames being discussed when talking about water quality. The report appears to emphasize the end state (50 years out) without any consideration of effects that may result in the interim period. KBRA actions are likely to take decades before improvements in water quality are observed. A key question then is the interim water quality conditions in the river in the period following dam removal and prior to assumed water quality improvements under the KBRA are implemented and the effects on coho and	The Panel found, and continues to find, a high level of uncertainty about the likely impact of KBRA on water quality throughout the system, and on any time scale. The Panel lacked the information to extrapolate a likely small (if any) reduction in nutrient loading on downstream water quality and fish

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			steelhead during this period. The panel notes that there may be minimal reduction in nutrient loading in the reach above Keno Dam even with the implementation of KBRA. How the failure to reduce nutrients in this area affects downstream water quality conditions and coho/steelhead production should be discussed. In this regard, Asarian et al. (2010) estimated that nutrient levels downstream of Iron Gate dam would increase under a 'without reservoirs' condition. The authors predict that under a dam removal scenario total phosphorus concentrations would increase 2 to 12 percent and total nitrogen would increase up to 37 to 55 percent. Thus, under the 'without dams' scenario, with continued seasonal water quality impairment from the upper basin, elevated nitrogen conditions would be expected to extend further downriver (the reservoirs have a larger impact on nitrogen retention than phosphorus, with May – September total nitrogen retention of approximately 34 percent) with the associated water quality impairment effects. Given the large nutrient loads in the river from UKL (and other upstream sources), "nutrient assimilation" by the river would result in proliferation of attached algae on the river bottom (e.g., periphyton like *Cladophora*). Periphyton provides an excellent habitat for the polychaete associated with C. shasta. Citations: Asarian, E., J. Kann, and W. Walker. 2010. Klamath River Nutrient Loading and Retention Dynamics in Free-Flowing Reaches, 2005-2008. Final Technical Report to the Yurok Tribe Environmental Program, Klamath, CA. 59pp + appendices.	production.
9	PacifiCorp	Pg 46; 3rd paragraph	Does the report here refer to active or passive re-introduction?	The report refers to active re-introduction. The Panel refers the

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			Also, the report notes that steelhead are likely to colonize the upper basin. Would this colonization be at the expense of the resident trout population? In other words, would total abundance be the same in a stream reach after re-colonization by steelhead?	commenter to the "Klamath River Expert Panel Scientific Assessment of Two Dam Removal Alternatives on Resident Fish".
10	PacifiCorp	Pg 47; Number (1)	Another factor that may reduce steelhead success is the size (length) of the typical adult resident rainbow compared to a steelhead adult. The panel saw pictures of "large " resident trout that were equal in size to the typical adult steelhead. These adults would likely compete with steelhead for spawning habitat.	This comment is noted.
11	PacifiCorp	P. 49; last paragraph	The panel should note that with dam removal water quality in the JC Boyle bypass reach will not provide as much high quality refuge habitats as it does currently. Most of the water currently in this reach is from the spring inflows supplemented by a 100 cfs release from JC Boyle dam. If JC Boyle dam is removed, the full flow of the Klamath River will occur in this reach and water temperatures will increase (Bartholow and Heasley 2005). Flows into the reach from June-August are expected to be in the 500-1,000 cfs range in order to achieve flow targets identified below Iron Gate Dam for this period under dam removal. Table 3 in the cited report shows that maximum water temperatures will be in the 18 to 21 °C range; average temperatures from 17 °C to 21 °C. Data presented in Table 12 of the report show that the number of kilometers of stream habitat with a mean daily water temperature of less than 16 °C is zero. In contrast, under current	The Panel responds that while the size of the thermal refuge may shrink under higher flows per the Bartholow and Heasley model, the Panel does not assume that this implies a net reduction in habitat quality under a dams-out scenario. The Panel emphasizes in this section that water temperature is a critical parameter, but not the only parameter of habitat quality; macroinvertebrate communities and hydrographs are also important responses to the dams-out alternative, and are expected to see

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			conditions 6.10 of the 7.22 kilometers of stream channel in this reach have a mean daily temperature of less than 16 °C. It is also likely that current DO conditions will likely degrade with increasing water temperatures in this reach because dissolved oxygen solubility decreases with increasing water temperature. Water temperatures leaving the mouths of Jenny and Spencer creeks are typically in the range of 20 °C -23 °C during the summer and should not be considered high water quality inputs. The panel should note that angler days for resident trout may increase, but this could be offset by a loss in angler days for fishers targeting reservoir fish communities such as yellow perch; a very popular fishery for this species exists in both Iron Gate and Copco reservoirs. Citation: Bartholow, J., J. Heasley (2005). JC Boyle Bypass Segment Temperature Analysis. Administrative Report to the US Fish and Wildlife Service and Bureau of Land Management.	improvements. Current resident populations of *O. mykiss* appear to do quite well at the projected temperatures where food supplies are good and other stressors minimal.
12	PacifiCorp	Pg 51: paragraph 1	The panel provides little to support the conclusion that steelhead production may decline under the dams in condition. The panel seems to be of the opinion that 1) actions proposed in the TMDL's for tributaries (Shasta, Scott, Salmon etc) to achieve temperature, nutrients, sediment targets, etc will be ineffective, and 2) on-going habitat restoration activities outside of the Biological Opinion for coho will also provide few benefits. If this is the case, then the panel should state this explicitly. If the panel has low confidence in TMDL actions then the same logic should be applied to TMDL actions proposed for the upper basin.	The Panel's opinion about the likely effectiveness of TMDLs is encapsulated in the final report.
13	PacifiCorp	Pg 51; Para 4	If the panel is of the opinion that more low velocity habitat will be produced in reaches where C. shasta could be present then	This is not the Panel's opinion but is based on a citation to the Stillwater

<table>
<tr><th>Comment Number</th><th>Comment Author</th><th>Page, Paragraph</th><th>Comment</th><th>Panel Response</th></tr>
<tr><td></td><td></td><td></td><td>they should also discuss how this may affect coho survival.</td><td>report.</td></tr>
<tr><td>14</td><td>PacifiCorp</td><td>Pg 57; Para 1</td><td>The panel should be clearer as to what is meant by reduced salmon carcasses and the link to disease. What is the metric being addressed here - total carcasses or carcasses per mile?

In regards to total carcasses in the system, under the dams out scenario this value is in theory supposed to rise substantially. Fish will now be produced in the reach below Iron Gate Dam, Keno to Iron Gate Dam and above Keno. Carcass levels may be reduced if Iron Gate hatchery strays make up a large portion of the natural spawning population and this production is eliminated. Evidence for this hypothesis can be found in Bogus Creek, where anywhere from 8-60 percent of the spawners are of hatchery origin. Average fall Chinook escapement to Bogus Creek is 8,800.

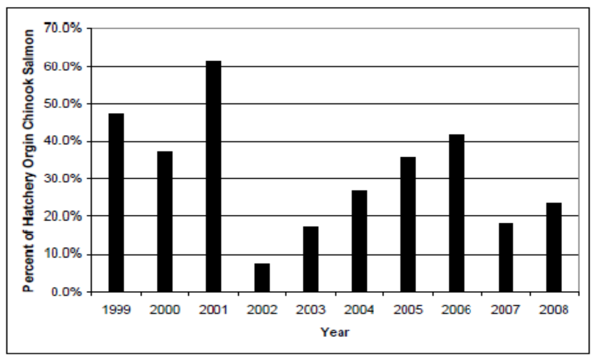

Figure 12. Estimated contribution of hatchery origin Chinook salmon observed in Bogus Creek from 1999 through 2008.

<u>Citation:</u> Knechtle 2009. Bogus Creek Salmon Studies 2008.</td><td>The Panel requested this information, but was not provided information on hatchery stray data.</td></tr>
<tr><td>15</td><td>PacifiCorp</td><td>Pg 57: Para 3</td><td>In regards to nutrients, Asarian et al. (2010) estimated that Total Phosphorous concentrations will rise 2-12% and Total Nitrogen concentrations will rise 37-42% following dam removal in</td><td>The Panel responds that these estimates are based only on the current retention in the reservoirs</td></tr>
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			reaches below Keno Dam (See above). KBRA actions may reduce these levels over time, but since it may take decades before KBRA actions are fully effective, water quality conditions in the period following dam removal - say 2020-2030 - may pose risks to both coho and steelhead populations. The panel may want to consider not only end state water quality conditions in their analysis but also water quality conditions during the interim period as well. It appears that the highest risk under the dam removal scenario may not be what happens if everything works as planned, but rather under an outcome in which they do not. In this regard, we did not see a discussion how changes in water quality may affect the estuary and ultimately coho and steelhead survival.	and do not take into account the changes in flows under the no-dam scenario. They do not account for the presence of large pools in the sediments behind the dams, which could be remobilized under flood conditions. Furthermore, estimates of (really rather modest) changes in TN and TP are insufficient to estimate effects over a period up to 50 years on water quality in the river or estuary.
16	PacifiCorp	Pg 63; 3.14.1	EDT results for steelhead were produced as part of the FERC record and should have been available to the panel (Response to November 2010 2005 FERC AIR-2). Results for Option 5 in this paper reflect possible steelhead production with the four dams removed and habitat restored to a level deemed possible by biologists familiar with the basin. Citation: Response to November 10, 2005, FERC AIR AR-2 Ecosystem Diagnosis and Treatment (EDT) Analysis PacifiCorp, Portland, Oregon.	The Panel responds that EDT results were not provided.
17	PacifiCorp	General	If the panel has not already evaluated the Lestelle (2006) report regarding coho life history patterns, it may wish to do so to inform its review. Citation: Lestelle (2006). A Review of Coho Salmon Life History Patterns in the Pacific Northwest and California for Reference in Assessing Population Performance in the Klamath River Basin.	This comment is noted. To confirm, the Panel relied upon the informative Lestelle 2010 report and his PPT presentation.

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			Prepared for U.S. Bureau of Reclamation Klamath Area Office, Biostream Environmental, Poulsbo, Washington. July 21, 2006.	
18	M.Knechtle	General	In may cases throughout the document coho and steelhead are lumped together when it seems more appropriate to separate the two animals based on their considerably different life histories.	This comment is noted. Where appropriate, the text has been revised for clarification.
19	M.Knechtle	6,4	The nature of the report excludes the Trinity River yet in some evaluations the Trinity is included. (i.e. proportions of hatchery coho in the basin (including Trinity) are very high yet if the Trinity is excluded from this analysis the proportion of hatchery coho in the Klamath excluding the Trinity is much lower page 40 paragraph 1).	This comment is noted. The Panel requested data on the portion of hatchery versus natural origin spawners by river area, but few data were provided.
20	M.Knechtle	10,2	Conditions with Dams are interpreted to not include any changes associated with the FERC relicensing agreement yet implementation of other basin plans. The FERC relicensing agreement includes fish passage an issue that may need to be considered?	This comment is noted. The report includes discussion of fish passage-related issues.
21	M.Knechtle	13.sec2.3.1	Harvest is listed under almost every general question. Every quantitative estimate of naturally produced coho abundance in the mid Klamath watershed are decreasing to levels close to extension and the inclusion of harvest in this section seams inappropriate.	This comment is noted. The Panel did not prepare the questions put to them.
22	Larry Hanson	17, 4	The degree of blockage to upstream and downstream migration is based on what? Temperatures, DO? The time frame of adult immigration into the upper basin would occur during the best environmental conditions in Upper Klamath Lake. Juvenile emigration out of the basin presumably would be in the spring of the year. Were the Keno Reservoir and Upper Klamath Lake	The Panel responds that data provided (Hamilton 2010 Fig 3) indicated DO levels are below 6 ppm for nearly 5 months of the year, from early July until mid-November.

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			reach environmental conditions evaluated for the migratory windows of these life stages?	
23	M.Knechtle, Larry Hanson	17,5	Uncertainty about the effects on hatchery fish introgression. As listed later in the document NMFS has recently evaluated this issue and found extreme low levels of divergence among the coho populations in the mid Klamath.	This comment is noted. The Panel responds that similarity is expected if there are high stray rates.
24	Larry Hanson	20, 2	Restoration, monitoring and reintroduction plans are to be developed by both Oregon and California in the near future. The comment in the document leads one to believe there is an "under-investment" in these areas.	This comment is noted. The Panel was not tasked to specifically evaluate the level of investment directed toward future plans.
25	Larry Hanson	22, 3	What life cycle model is being referred to and why was it pulled away from the expert panel?	This comment is noted. To clarify, the model was developed by Cramer's group, and the Panel was told that the model had not gone through proper review.
26	Larry Hanson	24, 5	Summarized Answers, Conditions without dams, All juvenile salmonid use the main stem Klamath River for rearing and migration.	This comment is noted.
27	Larry Hanson	24, 7	Only those juvenile fish that exhibit a yearling life history will need thermal refuge in the main stem.	This comment is noted. To clarify, all coho salmon and steelhead spend at least one year in freshwater.
28	Larry Hanson	29, 3	Where is the 30,000 acre-feet summer flow increase from Upper Klamath Lake Tributaries coming from?	The Panel has noted at various points in the report that we do not know where the 30,000 acre-feet is supposed to come from or where it will be introduced into the river system. Nor do we know what kinds

Comment Number	Comment Author	Page, Paragraph	Comment	Panel Response
				of constraints will be placed on pumping from groundwater to replace surface water rights sold to provide the 30,000 acre-feet. Furthermore, in Comment 63, below, reviewer Schlosser has informed us that the net number is only 20,000 acre-feet because in addition to retiring up to 20,000 acre-feet, KBRA will allow 10,000 acre-feet of extra groundwater extraction. Panel members do not recall being briefed on this latter offset. This is one of many uncertainties about the likely effectiveness of KBRA restoration activities.
29	M.Knechtle	30,4	Spelling. Change mainstream to mainstem	The report has been revised in response to this comment.
30	M.Knechtle, Larry Hanson	32, 3	How do these concentrations of sediment compare to natural flood conditions? If dam removal was delayed until Jan 1st verses Nov 1st the effects on adult coho would be significantly reduced for that given brood year. The first year of construction should be scheduled around the strongest year class of naturally produced coho in an effort to minimize short term negative effects to this important population. Current strong brood year of adult natural coho are expected to return in 2019, 2022, 2025	This comment is noted. The Panel sees no value in making detailed recommendations for design of the sediment release. We wrote that "Although there are important differences in the timing of the sediment releases among the various simulations that both groups [Stillwater Sciences and Bureau of

Comment Number	Comment Author	Page, Paragraph	Comment	Panel Response
			etc…	Reclamation] have made and in their separate preferred release strategies based on engineering logistics and fish protection, the major results are consistent…”
31	Larry Hanson	39, 4	Do these effects negate each other?	The report has been revised for clarification in response to this comment.
32	Larry Hanson	40, 1	Does this statement exclude the contributions of Shasta and Scott River coho populations?	The Panel is unclear as to which statement this commenter refers to. The topic of the section of the report involves coho salmon throughout the watershed.
33	Larry Hanson	40, 3	Temperatures in the main stem and temperatures and flows in the tributaries are the important factors to consider for adult coho immigration.	This comment is noted.
34	Larry Hanson	40, 4	This paragraph is talking about 2 different things, temperature on entry in the system and temperature at the Iron Gate Dam site. Both are important and both are key at different times.	This comment is noted. The data here refer to temperature near Iron Gate Dam.
35	B.Chesney	41, 1	The Shasta River is not naturally a warm stream. Unimpaired summer base flows from cold spring sources and snowmelt have been estimated to be approximately 200 cfs (NRC 2004, Null, et al. 2010). The current summer temperatures and diminished spring and summer hydrograph are due to water diversions and used irrigation water returning to the stream at elevated temperatures. Prior to irrigation development and the construction of Dwinnel Dam, spring Chinook a species known to require cold water, were present in the system (Curtis 1922,	This comment is noted. The report has been revised for clarification in response to this comment.

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			DWR 1964, Snyder 1930, Wales 1952, Moyle 2002, in Chesney et al. 2006). What has been described as the use of cold water refugia by juvenile coho is in fact their use of the remnant of cold water habitat upstream of irrigation impacts. Effective implementation of tail water reduction and riparian restoration through the Incidental Take Permit and KBRA has the potential to increase the amount of summer rearing habitat available and increase juvenile survival and the production of smolts.	
36	M.Knechtle	42,3	"Fish may also be more susceptible to pathogens…" Current understanding of C.shasta spore transmission indicates that at temperatures below 10 degrees C transmission is low and significantly increases above 10 degrees C. If this is true is the potential risk of disease transmission with increased spring water temps understated?	This comment is noted.
37	M.Knechtle	43,3	"…90% of coho salmon in the Klamath Basin…" As stated in comment 2 if the huge hatchery program on the Trinity is removed from this analysis the proportion changes dramatically.	This comment is noted. The Panel asked for hatchery versus natural origin coho by area, but did not receive the data.
38	M.Knechtle	43,4	"…coho spawning habitat quantity and quality is limiting reproductive success…" The current spawning gravel is able to support one brood year that is significantly larger than the two others therefore it seems unreasonable to conclude that spawning gravel is limiting production of the two weaker year classes of coho.	This comment is noted. The Panel still states that there has not been an assessment to determine whether coho spawning habitat quantity and quality is limiting reproductive success.
39	M.Knechtle	45,2	On what basis is the statement made. "Population response of coho salmon are expected to be marginal". Coho salmon have penetrated the interior portions of the Yukon River in AK and have the ability to migrate great distances when given the	The Panel agrees that coho can migrate many miles upriver, but that does not mean that they will. There are many places with ideal coho habitat in Alaska, yet no coho

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			opportunity.	salmon present. This summary statement is supported by the discussion in the report.
40	B.Chesney	48,2	It is unclear why coho should be less likely than steelhead to colonize suitable habitat upstream if the dams are removed. A study of the behavior of PIT tagged juvenile coho in the Shasta River in 2008 found that coho as small as 60 mm were able to seek out suitable habitat by swimming upstream over four miles in six day (Chesney et al 2009). It seems likely that if given the opportunity they will behave the same way if new habitat is accessible in the upper basin.	The Panel believes that steelhead responses are likely to occur much more rapidly, and across a greater geographic range within the project reach and upstream, given current healthy populations of *O. mykiss* in these reaches. Coho have the potential to colonize new habitats, but will also need productive populations to achieve responses. The report provides the Panel's rationale for factors influencing likelihood of colonization. The report has been revised for clarification in response to this comment.
41	M.Knechtle	48,3	"…much less important for coho salmon unless they too are able to colonize and become productive in upper basin habitats" On what basis is this statement made. See comment 11.	The Panel responds that if coho salmon are unable to establish productive populations in Upper Klamath Lake tributaries, then they obviously will not be able to benefit from the coldwater habitats available there.
42	Larry Hanson	49, 7	The Salmon River, Elk Creek, Clear Creek, Dillon Creek and Indian Creek all have populations of summer steelhead. These	The report has been revised in response to this comment. Inconsistencies among source

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			watersheds are not in the lower basin.	material regarding definition of “lower”, “middle” and “upper” river were noted.
43	M.Knechtle	51,1	KBRA not KRBA	The report has been revised in response to this comment.
44	M.Knechtle	51,3	KBRA not KRBA	The report has been revised in response to this comment.
45	Larry Hanson	52, 3	What are the limiting factors in the Keno Reservoir and Upper Klamath Lake reaches? Are they factors that effect emigration or immigration?	The Panel was provided with information suggesting the need to improve DO and temperature conditions, particularly within the Keno Reservoir; several sources even implied that trap and haul would be necessary to move fish past Keno Reservoir.
46	M.Knechtle	54, 4	Chinook not chinook	The report has been revised in response to this comment.
47	Larry Hanson	54, 5	Trap and haul programs on a long term basis are a losing proposition.	The Panel notes that the discussion in the report is consistent with this comment.
48	Larry Hanson	55, 1	Are O mykiss populations occupying habitat above Upper Klamath Lake remnants of historic steelhead populations or did these populations co-exist pre-dams? Population levels of resident O mykiss population should adapt to steelhead presence in the watersheds.	The Panel recognizes that the scientific understanding of residency and anadromy in *O.mykiss* is still evolving; the Panel’s assumption is that anadromy is most likely from the less environmentally stable (non

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				spring-fed) Upper Klamath Lake tributaries. Residency may be a much more profitable life history for *O. mykiss* in the productive, stable spring creek tributaries of Upper Klamath Lake.
49	Larry Hanson	56, 6	Scott River not Scott Creek.	The report has been revised in response to this comment.
50	M.Knechtle	57,4	"…Chinook salmon carcasses (mostly hatchery fish) concentrated downstream of the dam,…" The section of river that the panel is referring to is close to the hatchery but has traditionally had extremely low hatchery contribution rates.	This comment is noted. The Panel requested data on hatchery versus natural origin Chinook in this reach but did not receive data or reports. The Panel did hear that there were differing estimates of hatchery strays. High hatchery strays makes sense, given the hatchery proximity, and the fact that many hatchery fish obviously stray into Bogus Creek.
51	Larry Hanson	58, 7	Of the 10.3 (not 8.5 million) million Chinook released from basin hatcheries 4.3 million are released from TRH and approximately 6 million are released from IGH.	This comment is noted. The Panel used data that were provided by the hatcheries after the Panel requested the data. Unfortunately, a comprehensive spreadsheet of hatchery data was not available.
52	Larry Hanson	61, 4	Harvest levels of wild and hatchery origin coho have not been reported to the panel because there is no allowable harvest.	This comment is noted. The NMFS BO states that there has been some harvest by Tribes. Some harvest data were provided for the early

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				2000s.
53	M.Knechtle	63,6	"…this population assessment was largely based a simple conceptual…" insert "on" to read …based on a simple…	This statement has been removed from the text of the final report.
54	B.Chesney	(none provided)	<u>Annotated Bibliography</u> California DWR (Department of Water Resources). 1964. Shasta Valley Investigation. California department of Water Resources Bulletin 87. 170 p. *Spring-run Chinook entered the Shasta during May and June. This population was maintained throughout summer by conditions provided by the cool, steady flow of Big Springs. These fish spawned with the appearance of fall freshets and increased flows (p. B-17).*	This comment is noted. The information provided in this comment was considered by the Panel.
55	B.Chesney	(none provided)	Chesney, W.R., C.C. Adams, W.B. Crombie, H.D. Langendorf, S.A. Stenhouse and K.M. Kirkby. 2009. Shasta River juvenile Coho habitat and migration study. *PIT-tagged juvenile coho sought out suitable cold-water habitat, in response to increased water temperature, by swimming upstream over four miles (p. 7, pp. 102-137(Appendix 13)).*	This comment is noted. The information provided in this comment was considered by the Panel.
56	B.Chesney	(none provided)	Curtis, E. S. 1922. The North American Indian, Volume 13, page 113.	This comment is noted. The information provided in this comment was considered by the Panel.
57	B.Chesney	(none provided)	Moyle P. B. 2002. Inland Fishes of California, revised and expanded. University of California Press, Berkeley, California, USA.	This comment is noted. The information provided in this comment was considered by the Panel.

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			Spring-run chinook were eliminated in the Shasta River in the 1930's after the construction of Dwinnell Dam. The dam caused habitat degradation and increased summer water temperatures. Historically, the run of Spring Chinook in the Shasta River was probably the largest tributary run in the Klamath drainage (p. 259).	
58	B.Chesney	(none provided)	NRC (National Research Council). 2004. Endangered and threatened fishes in the Klamath River Basin: Causes of decline and strategies for recovery. Committee on endangered and threatened fishes in the Klamath River Basin, National Research Council. The National Academy Press. *Before water development, the Big Springs complex supplied 103 f^3s^{-1} to the Shasta River. Flows from springs and accretions "would have supplied flows close to or exceeding today's bankfull condition, even during summer months." (p. 154). The Shasta River historically flowed at a minimum of about 200 f^3s^{-1} year-round (p. 289).*	This comment is noted. The information provided in this comment was considered by the Panel.
59	B.Chesney	(none provided)	Null, S.E., M.L. Deas and J.R. Lund. 2010. Flow and water temperature simulation for habitat restoration in the Shasta River, California. River Research and Applications, 26: 663-681. *Reiterates NRC 2004 in that prior to water development, Big Springs supplied 2.9 m^3s^{-1} (103 f^3s^{-1}), or half the unimpaired baseflow, to the Shasta River. Today it contributes 2.0 m^3s^{-1} (71 f^3s^{-1}) (p. 4).*	This comment is noted. The information provided in this comment was considered by the Panel.
60	B.Chesney	(none provided)	Snyder, J. O. 1931. Salmon of the Klamath River California. Division of Fish and Game of California. Fish Bulletin No. 34. *Spring-run Chinook salmon entered the Shasta in June and early-July. Historically both fall and spring runs had contributed much*	This comment is noted. The information provided in this comment was considered by the Panel.

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			to the overall population of the main river (p. 31).	
61	B.Chesney	(none provided)	Wales, J. H. 1952. The decline of the Shasta River king salmon run. Bureau of Fish Conservation Division of California Department of Fish and Game Report. 82 p. *States that most of the Chinook entering the Shasta River are fall-run fish. It was deemed improbable that the spring-run population, formerly substantial, would ever increase (p.64). Diversion of water for irrigation reduces flow to a level prohibitive for the entry of salmonids, that Is, until mid-September (p.62). Water temperatures during these summer months may approach 85 F (30 C).*	This comment is noted. The information provided in this comment was considered by the Panel.
62	T.Schlosser	iii, 1	Obstacle (5) "water demand responses to KBRA" is unclear. Does this mean water consumptive uses authorized by KBRA?	Not exclusively. To clarify, the statement refers to changes in water demand in response to KBRA implementation, including water consumptive uses.
63	T.Schlosser	12, Tbl. 3	Reference to "acquisition of 30,000 acre-feet" is misleading because the authorized water diversions for the Klamath Reclamation Project will increase by 10,000 acre-feet, following dam removal, so the net increase in river flow will not exceed 20,000 acre-feet. KBRA § 15.1.1. One should not expect a 30,000 acre-feet increase to the river brought about by water rights retirement in the Upper Basin.	The Panel received conflicting information on this, but the quantity of this acquisition was not a key factor in the Panel's opinion.
64	T.Schlosser	22, 1	Reference to "irrigation withdrawals," the only place they're mentioned in the document, understates the connection between water usage and fish habitat.	The issue of irrigation withdrawals is discussed in several other places in the document. However, the Panel responds that it is not possible from the published data to make an

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				overall judgment of the magnitude of pumping effects on water-table heights, riparian vegetation, wetland distribution, or wetland function. The relative importance varies seasonally and geographically, and the report briefly summarizes what is known about the topic.
65	T.Schlosser	24, 7	Is there a connection between "high water temperatures in the river" and out-of-stream water use authorized by KBRA?	The Panel does not have the information to determine this.
66	T.Schlosser	29, 3	*See* comment on page 12 regarding 30,000.	See response to comment 63.
67	T.Schlosser	31, 3	*See* comment on page 12 regarding 30,000.	See response to comment 63.
68	T.Schlosser	36, 3	Is the hindcast modeling of "conditions with dams scenario," also weakened by the inclusion of many years when demand for out-of-stream water use was unconstrained by the Endangered Species Act?	The Panel is unaware of any hindcast modeling that did or did not take this into account. The Panel attempted to compare two scenarios for the future.
69	T.Schlosser	47, 5	The reference to "current upper basin land use and depleted hydrology" is too cryptic. If possible, the panel should comment on whether KBRA measures adequately address those factors.	This comment is noted. The reference seems adequate to the Panel. The Panel stated that there is insufficient information about KBRA proposals to judge whether they will be adequate.
70	T.Schlosser	67, 2	The assumption "that the mandate of July through September flows (NMFS BO for Coho Salmon) would be maintained during future climate scenarios" is unjustified. KBRA § 21.3.1.B	The Panel is not in a position to judge what might happen to current or future agreements in the face of

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			commits non-federal parties to support approval under the ESA (an HCP) for diversion of water for the Klamath Reclamation Project as provided in KBRA. Those diversions will reduce summer flows.	climate change and socio-economic changes in the basin. All the Panel can do is to point out the assumptions that the Bureau of Reclamation made in their modeling of flows and lake levels under future climate scenarios.
71	T.Schlosser	67, 2	The assumption "that the mandate of July through September flows (NMFS BO for Coho Salmon) would be maintained during future climate scenarios" is unjustified. KBRA § 21.3.1.B commits non-federal parties to support approval under the ESA (an HCP) for diversion of water for the Klamath Reclamation Project as provided in KBRA. Those diversions will reduce summer flows.	See response to comment 70.
72	R.Franklin	i, 2	Regarding the statement "However, the Panel's statements are no substitute for further scientific investigation. The Panel recommends that its statements not be used in lieu of doing the necessary and feasible data collection, analyses, and modeling that is recommended below.", we consider it unlikely that the Panel's recommendations for followup science will be heeded. Therefore, a more direct description from the Panel as to how to use the information in the Report would be helpful.	The Panel has provided answers to the questions posed wherever possible, based on the available information. It has also pointed out where major uncertainties exist, and made recommendations of how some of these uncertainties might be resolved.
73	R.Franklin	17, 2	Regarding the statement "The questions posed to the Panel are not answerable with a satisfactory degree of precision or confidence. " We strongly agree. In fact the HVT team has pointed to this fact throughout Settlement discussions, this in the face of federal and state fisheries scientists reaching the conclusion that fisheries benefits of KBRA are somehow clear to see – and reliable. Recommend that this text, with its simple statement of limits of Settlement science, be elevated to	The report has been revised for clarification in response to this comment.

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			"headline" status. This phrase would be extremely useful in the Executive Summary.	
74	R.Franklin	18, 2	In regards to" Furthermore, *a decision to proceed with the projects should be understood as a decision to pursue a hypothesis, for which there is some evidentiary support, but whose outcome is largely unknown.* In this spirit, the panel highlights the following four important topics: a. The processes, controlling factors, and hazards likely to have the greatest influence on project outcomes should be identified ***now***. b. Experiments and studies can be carried out between ***now and the planned date for dam removal (2020)*** to reduce some of the uncertainties, which in turn may provide guidance and direction for the KBRA. c. Monitoring programs should be planned, coordinated, and implemented ***now*** for effective and timely detection of the consequences for the salmon of the grand experiment comprising the dam removal and KBRA program. A monitoring program should be designed and established ***as soon as practicable*** to provide useful and timely guidance for KBRA and the design of dam removal. d. A scientific advisory structure should be implemented ***at the beginning of the planning process*** that is conducive to effective and timely redirection of KBRA mitigation and restoration activities in response to monitoring and experimental results, on an ongoing basis, so as to discontinue ineffective and counterproductive activities, while trying new ideas and maintaining and fine-tuning activities that prove effective." While the panel has in this text offered what is essentially their view of requisite	This comment is noted. The Panel made some recommendations; it is up to the various agencies and stakeholder groups to decide which of these, if any, to implement, and determine the consequences of implementing these or failing to do so.

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			follow-up science, it is unlikely that all of these (perhaps any) will be implemented. Therefore, the Panel should consider stating their position on what should be done if the recommendations are not followed. For instance, should a decision be delayed until after KBRA documents (i.e. Drought Plan, Fisheries Restoration Plan) have been written and analyzed?	
75	R.Franklin	20, 1-4	There are a series of recommendations regarding use of scientific leadership. Please state what risks would be faced if the program is implemented without the recommendations. Would fisheries outcomes for instance be unreliable?	See response to comment 74.
76	R.Franklin	31, 2	"The KBRA is intended to result in some adjustments to the late summer flow regime by increasing flows slightly in July through September, and decreasing them in October-December (B. Greimann PPT Presentation 12/13/2010, see Figure 4 above)." Given that the reduced flows in October through December fall frequently below the Ecological Base Flow limit identified in Hardy et al. 2006, what is the Panel's impression of biologic consequences? As defined in Hardy et al. 2006, flows in the range contemplated by KBRA will fail to provide minimal (subsistence level) conditions. Furthermore, these extreme conditions will repeat annually, affording no relief.	The Panel was charged with comparing the two alternatives. The Panel report addresses the rather modest changes in flow that would be expected under the Proposed Action.
77	R.Franklin	33, 1	Discussion of oxygen sag during first evacuation of reservoirs is incomplete and needs to be updated. Misses the point that "decreased" levels of oxygen are potentially lethal to fish throughout the Iron Gate to Shasta River reach (approximately), depending upon a variety of factors including water temperature and ambient oxygen levels in reservoir depths at time of breaching. Please address biologic impacts of a range of acute	The Panel agrees that there is a potential for harmful levels of oxygen during the transient around drawdown of the reservoirs and removal of the dams. This transient effect can be minimized by appropriate timing and in any case the long-term effects of the project

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			low-to-zero oxygen events.	are of greater concern.
78	R.Franklin	51, 1	"The Panel can only state that if the KRBA is implemented effectively, improved habitat conditions are likely for steelhead." This says to me that if things get better then things will get better. Recommend describing what effective and ineffective implementation might look like in this regard.	The Panel responds with clarification that the answer depends on what is meant by "effective." The Panel used this to mean that KBRA actions would achieve some set of objectives related to habitat – i.e., that effectiveness of KBRA would be measured not only by actions taken but also by the results of those actions in terms of habitat improvement. In that sense, this statement could be construed as circular, but Panel members have seen too many restoration programs in which outcomes were judged no further than the actions themselves (e.g., how much gravel was dumped into a river) without an attempt to say what the outcomes were in terms of the target species or their habitat. In that sense, this is not circular.
79	R.Franklin	52, 4	"The KBRA is a list of possible actions without sufficient detail to quantify their effects on habitat, and the data and modeling needed to quantify the response of steelhead to these changes in habitat are lacking." This stands as a general statement regarding the relationship between the too-vague KBRA and	The report has been revised to include a similar statement in response to this comment.

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			analysis of impacts to native fishes. We strongly agree, and recommend this be incorporated to the top of the Executive Summary, at paragraph 2.	
80	R.Franklin	63, 4	"The 2-D habitat modeling known to the Panel was presented in Hardy et al. (2006), which did not simulate the Conditions without Dams and with KBRA alternative and was restricted to the reaches downstream of the Iron Gate Dam." The cited study provides criteria for the limit of subsistence-level flow conditions – known as Ecological Base Flows – which pertain to either the Dams Out or No Action alternatives. The EBF flow limit is not impacted by the presence of dams, as this is based solely on statistical analysis of native hydrology. The Panel should review hydrologic simulations of the Alternatives and state its impression of the likely impacts to coho and steelhead of providing less than minimal flows in October, November and (sometimes) December of each year.	This was not part of the Panel's charge, although the Panel report discusses the fact that flow augmentation under the Proposed Action would be small.

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81	Dunsmoor	i, 1	The decision standards the Secretary is to use in his decision-making regarding facilities removal were carefully crafted and intensively negotiated in the KHSA, and they need to retain their integrity in the expert panel review process. The Secretary's decision standards are whether Facilities Removal under the KHSA 1) will advance restoration of the salmonid fisheries of the Klamath Basin, and 2) is in the public interest, which includes but is not limited to consideration of potential impacts on affected local communities and Tribes. To the extent that the panel limited its scope to responses of listed populations, the mark was missed. The KBRA has its own set of fishery and ecosystem goals (e.g. KBRA sections 9.2.1, 9.2.6, 10.1.2, & 16.3) which cover listed species by default, but the KBRA has no standards applicable to the Secretary's decision. The panel should appropriately consider the effects of implementing the KBRA in terms of restoration and resource management synergies with facilities removal under the KHSA.	The report has been revised for clarification in response to this comment, although it has little effect on the Panel's response to the questions put to them. Note that the Panel's charge was steelhead and coho salmon, the latter a listed population.
82	Dunsmoor	iv, Table ES-1, Water Quality	The KBRA and KHSA are comprehensive legal agreements, not resource management or scientific documents, and hence they do not provide much direct help to the Panel in answering the specific questions posed to them. Each agreement defers detailed planning and implementation to post-agreement processes not yet completed. However, I believe the Panel errs in concluding that "The limited detail provided in the KBRA suggests minimal reduction in nutrient loading and increase in dissolved oxygen levels upstream of Keno Dam". Here is why: 1. We expect to curtail external loads through the KBRA actions detailed in Barry et al. (2010; filename:	This comment is noted. The Panel is less optimistic than the commenter about the likely success of unspecified restoration actions in achieving a sufficient improvement in water quality to reduce or eliminate problems for migratory fish. The Panel points to the limited degree of success of such restorations in other areas where non-point-source loading is the problem. The text on *Microcystis* was incorrect and has been modified in response to this

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			KBRA_restoration_actions_and_costs_July_30_2010.pdf); 2. In section 10.1.2 of the KBRA, restoration actions will include measures to manage and reduce "… organic and nutrient loads in and above Keno Reservoir and in the Klamath River downstream". $55 million is identified for this purpose (KBRA Appendix C-2, lines 11-12); 3. KHSA Interim Measure 10 (pg D-2) is specifically oriented towards identifying nutrient reduction measures, and is being developed now. While not finalized, the workshop objective presently being used by the steering committee is "To identify the technologies and strategies that will provide a clear working framework to reduce nutrient and organic matter loads to the Klamath River and improve water quality conditions within the Klamath Basin. Workshop participants and experts will be invited to evaluate the merits of various pollution reduction options for the Klamath Basin and develop recommendations for the development of engineering feasibility analyses for the most promising pollutant reduction options evaluated at the workshop." Technologies to be focused on include: • Wetland treatment systems • Wastewater treatment systems • Algae / biomass removal • Ambient water treatment systems • Sediment nutrient sequestration • Others (we're encouraging innovation). 4. KHSA Interim Measure 11 (pg D-2) is intended, in part, to plan and implement nutrient reduction measures. Two feasibility studies are moving forward now: a) Evaluation of Organic Material Removal from Keno Reservoir and the	comment.

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			Upper Klamath River (filename: IM_11_Study_Plan_Keno_OM_Removal__Oct_18_2010_.pdf); b) Evaluation of Treatment Provided by Wetlands (filename: IM_11_Study_Plan_Treatment_Wetlands__Oct_18_2010_.pdf). Whether nutrient reduction measures are implemented in Upper Klamath Lake or in Keno Reservoir, they are intended in part to reduce the flow of nutrients and organic matter into and from Keno Reservoir, and thereby improve water quality in and below Keno Reservoir. I believe conclusions of Sullivan et al. (2010; filename: Sullivan_chemgeo_Keno_resv_bod_2010.pdf) support the notion that removing organic material in the form of algae and other particulates will remove substantial BOD from the system. 5. Finally, what could be more certain than that *Microcystis* blooms will be reduced, since removing the dams removes the reservoirs in which the blooms form and persist?	
83	Dunsmoor	iv, Table ES-1, Adult/Juvenile Migration	Why is this question limited to below Iron Gate Dam? It was not put to the Panel in that form. Dam removal will return the thermal regime in the Klamath River to a normative condition, or nearly so, in that it will restore the spatial and temporal variability springing from responsiveness to meteorological conditions. Dunsmoor and Huntington (2006; filename: Migratory Corridor Technical Memo FINAL revision 1 red.pdf) show this in several ways. First, Figure 21 shows that the summer-fall thermal regime shifts towards what was measured below Iron Gate Dam in 1926. Second, Figures A13-A26 in Appendix A show the seasonal and longitudinal patterns of temperature magnitude and variation (EC = existing	The Panel responds that there was significant redundancy in the original questions. Therefore, issues involving adult and juvenile migrations upstream of Iron Gate Dam were covered in other sections of the report. The report has been revised to provide clarification regarding how the questions put to the Panel were restated in the text. Note that the full text of questions put to the Panel are provided in

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			conditions with all dams in place; No IG-COP-JCB is the dam removal scenario being considered under the KHSA). The Panel concludes that juvenile coho movements are impeded by high summer temperature in the mainstem under the Conditions With Dams scenario, and also that higher summertime temperatures are a negative effect of the Conditions Without Dams and With KBRA scenario. However, the foregoing figures show a much more complex thermal response to dam removal. While summertime water temperatures can be higher without the dams, they can also be lower. Thermal regimes in reaches below the dams have very low variation for extended periods, so when temperatures ascend to levels impeding juvenile movement, they remain adverse regardless of short-term meteorological events. Conversely, without the dams in place, water temperatures respond rapidly to air temperature changes, and these events create spatial and temporal thermal diversity that could be exploited by juvenile fish. I would argue that more opportunity for movement exists without the dams than with them during the warmest part of the year, although I am unsure of the extent to which this may influence coho performance, since warm summer water temperatures are a natural feature of this river and it seems unlikely that extensive summertime movement has ever been possible.	Appendix B of the report. The second comment provided is noted. The Panel responds that the text of the report notes that temperature fluctuations would be greater with dams out.
84	Dunsmoor	v, Table ES-1, Tributary vs Mainstem Spawning	Again, why is this question limited to below Iron Gate Dam? It was not put to the Panel in that form; removal of the dams immediately increases availability of main stem and tributary spawning habitat. The Panel concludes that "any benefit to improve spawning habitat of coho depend on unspecified KBRA activities targeting spawning habitat". What about simply providing access to tributaries between Iron Gate and Keno Dams? At a minimum,	See response to comment 83. The Panel responds that access to tributaries above Iron Gate Dam is discussed in a question that is more specific to this area.

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			Spencer, Shovel, Fall creeks will certainly provide an immediate increase in tributary spawning. See Huntington and Espinosa (2006; filename: MEMO_HuntingtonandEspinosa2006.pdf)	
85	Dunsmoor	v, Table ES-1, Access to Habitat	Significant habitat for steelhead and coho will be provided between Iron Gate and Keno dams. See Huntington and Espinosa (2006; filename: MEMO_HuntingtonandEspinosa2006.pdf)	Table ES-1 has been removed from the report for clarification.
86	Dunsmoor	vii, Table ES-1, Climate Change	Restoration measures under KBRA are more likely to improve thermal conditions than water management actions. Sufficient detail is provided by Barry et al. (2010) to support that conclusion, assuming that they are implemented in an effective manner, and that they have the intended results.	See response to comment 85.
87	Dunsmoor	1, 1, last sentence	See comment 1. The Secretary's decision pertains to Facilities Removal under the KHSA, and the standards are stated incorrectly here.	The report has been revised for clarification in response to this comment.
88	Dunsmoor	11, 2.2.2.1	Removal of the dams opens up fish access to the entire drainage upstream, as limited by natural fish barriers and by seasonal water quality barriers in Keno Reservoir and Upper Klamath Lake.	The report has been revised for clarification to this comment.
89	Dunsmoor	12, Table 3	The last row in the table incorrectly says "Acquisition of 30,000 acre-feet of water". Instead it should say something like "Permanent retirement of water uses sufficient to increase annual inflow into Upper Klamath Lake by 30,000 acre feet". To the extent that water rights will be changed, it will be through retirement, not through acquisition, which implies that someone else will take and hold the water right. This is not merely a fine point, but rather one of profound political significance locally, so it is important that it be correctly stated here.	This comment is noted.

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90	Dunsmoor	17, #2: Serious uncertainty about fish passage and colonization.	Indeed, a seasonal (late summer – fall as needed based on water quality conditions) trap and haul from below Keno Dam to somewhere above Link River Dam has always been the intent. Such a program was required in 2007 as a Mandatory Term and Condition of a new hydropower license, and the fish managers plan to implement that program adaptively. As water quality conditions improve we intend to eventually eliminate trap-and-haul. Power generation at Link River Dam will have ceased, and there is none at Keno Dam, so downstream mortalities associated with power generation will be zero.	The Panel agrees that a trap-and-haul program might not be necessary when water quality improves. But the NRC (2004) report indicated that improving lake water quality is likely to be a difficult and uncertain task, and the Panel agrees.
91	Dunsmoor	17, #5: Uncertainty about how land owners will accommodate to the KBRA.	The Klamath Irrigation Project is a party to the agreement, the implementation of which will decrease surface water diversion and monitor and limit adverse effects of groundwater use by the Project (see KBRA Section 15.2.4).	This comment is noted.
92	Dunsmoor	18, 2, Furthermore…	We face a serious management decision about whether to keep the dams or to remove them. While I won't disagree with the general theme of the statement in italics, I find that its context is self-limiting and therefore skewed, because it considers only the alternative of removing the dams. How uncertain is the outcome for the river and for the species if we keep the dams? Will we even have a chance to restore any fish populations to the Upper Basin? Will the present downward trends of existing populations continue? Can the problems with thermal regimes and *Microcystis* blooms be ameliorated with the dams and their reservoirs in place? I could list many more such questions, but my point is that the central question is this: which of the 2	This comment is noted. The report has been revised for clarification in response to this comment. In response to many comments, the Panel has revised the report to make clearer that the focus was the contrast between the two alternatives presented. The Panel believes that it is great that agencies will pursue the items

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			alternatives is likely to improve the fisheries and the ecosystem that produces them, not the extent to which we can fully quantify all outcomes of dam removal. Additionally, the statement implies a single outcome to dam removal, declared to be unknown. But we know that removing the dams a) eliminates *Microcystis* blooms and toxins emanating from the reservoirs; b) restores the river to a more normative thermal regime; c) reconnects upstream ecological processes and habitats to the Klamath River below Iron Gate, including some of the largest scale thermal refugia in the entire basin. More could be said along these lines, but the point is that we do know some outcomes with confidence, and we also know with confidence that we cannot manage our way around many of the most severe problems caused by the dams while they remain. Finally, I agree with the Panel's recommendations in a-d, and in fact would say that we have our eyes on the ball for each of these. The Fish Managers are developing restoration and monitoring plans. The Technical Advisory Team will be active on the science front. A NFWF funded evaluation of past Upper Basin restoration actions is underway and will be used to guide subsequent projects and strategies, Chinook reintroduction work is to begin in 2012 with research into stock selection, evaluations of timing, location, and methods associated with stocking embryos or fry above Upper Klamath Lake, evaluations of Chinook performance moving through Upper Klamath Lake, etc.	listed in a-d of the comment. However, information on some of these issues was not provided to the Panel, such as experimental studies to evaluate colonization of Chinook salmon above Upper Klamath Lake.
93	Dunsmoor	24, last sentence on page	High summertime water temperatures in the Klamath River are a natural feature of this system, see Without Project (WOP) scenarios in Dunsmoor and Huntington 2006, Figures 19-21; filename: Migratory Corridor Technical Memo FINAL revision 1 red.pdf). No alternative is available that would keep temperatures in the range that would not require access to	The Panel responds that there is nothing in this comment that the Panel would disagree with, or that conflicts with the text of the report. However, the Panel states that there seems little point in the Panel

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			thermal refugia. The existing condition provides the fish with high water temperatures in summer and fall that vary little, whereas the dam removal scenario provides high summer water temperatures that vary a lot. Bisson et al. (2009) argues that habitat management for Pacific salmon should in part strive to provide normative patterns of variability in physical processes that create habitat diversity. Removing the dams will accomplish this better than any available alternative insofar as the thermal regime is concerned.	adding qualitative speculation of the kind referred to in the Bisson et al. document. The Panel was not charged with repeating one more general review of the literature on river restoration. That would have been more useful in the original agency documents provided to the Panel, along with some quantitative estimation of the degree to which the Bisson recommendations would be met by the proposed KBRA activities.
94	Dunsmoor	29, middle paragraph	Here and elsewhere it appears that the Panel assumes woody riparian vegetation to be the potential natural plant community throughout the riparian corridor of the Sprague River, when in fact sedges and rushes were likely the dominant forms in much of the valley floor. See pages 8-13 in McDowell and Massingill (2008); filename: UO_Riparian_Study_Final_Report.pdf.	The report has been revised for clarification in response to this comment. The Panel has inserted a reference to sedges, together with a comment on the confusing nature of references to the value of riparian vegetation in the various KBRA documents. However, the Panel was unable to locate files named "McDowell and Massingill (2008)"or "UO_Riparian_Study_final_Report.pdf" in the files supplied to the Panel. The Panel comments that this is another example of the inefficiency with which materials were provided.
95	Dunsmoor	31, Section 3.2.5	The KBRA re-operates the system to provide significantly more water below Iron Gate during the spring months (April-June)	The Panel was asked to compare current conditions with dams and

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			when compared to historic conditions since 1960, moving the river back towards a normative flow regime. This is largely lost on the Panel, I believe, because the Panel focused on comparing hydrographs between KBRA and Biological Opinion outcomes, both of which represent significant change from the historic condition. Springtime flows are very important for anadromous fish, more so than summer flows – the Panel's focus here seems off-target.	the established flow regime (controlled partially by the Biological Opinion) with the proposed KBRA without dams condition. That is why the Panel focused on these two flow projections - although the Panel emphasized that there remains considerable uncertainty about the reliability of flow modeling.
96	Dunsmoor	35, 1st paragraph	KBRA also plans gravel augmentation to the main stem Klamath – see Section 10.1.2 which states: "Within these specific elements, the Phase I Plan will address, among other things: (i) coarse sediment management in the Klamath River between Keno Dam and the Shasta River confluence, where coarse sediment supply will be managed, in coordination with any plan for Facilities Removal, to replenish and sustain existing in-river sediment storage capacity, which may subsequently be increased after evaluating the attendant biological benefits…"	The Panel responds that the suggestion provided is unclear. The Panel acknowledges that KBRA planning includes a menu of qualitative concepts for potential restoration actions. But the magnitude, extent, and likelihood of effectiveness have not been addressed by the planning agencies. It is therefore impossible for the Panel to make projections of the likely effectiveness of KBRA on fish populations. The Panel's opinion on this subject is clearly stated in the final report.
97	Dunsmoor	36, paragraphs 3-4	The Panel concludes that the model-predicted 18 day phase shift in the thermal regime is not a sure thing because of climate change, water demand scenarios, or KBRA actions. I disagree for several reasons: 1) Dunsmoor and Huntington (2006) present biological corroboration of the thermal regime shift in terms of	The Panel notes the distinction between coho salmon and steelhead, with the shift being of benefit to steelhead. However, the panel also notes that there was sufficient uncertainty in the

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			coincident shifts in fall Chinook run timing (Figure 22) and though comparison of measured temperatures in 1926 to model predictions (Figure 21). 2) The reservoirs store heat. The thermal response to removing the reservoirs is not "plausible", it is a physical certainty. The river will be much more responsive following reservoir removals to climate forcings, which will by far dominate the thermal outcome in the river. Thus, the trajectory of climate change will indeed be important, but as noted it will occur regardless of reservoir removal. The reservoirs have caused impacts during the late summer and fall that worsen the potential effects of climate change. 3) Water leaves Upper Klamath Lake equilibrated to air temperature. Once water flows past Keno it flows through steep reaches, where turbulent flow will ensure equilibration with air temperature. There are no actions contemplated under the KBRA that could have an effect that would overwhelm these physical processes. I find the Panel's concerns on these points to be unconvincing. 4) Models undoubtedly do not provide us exactly accurate predictions of what the effects of dam removal would be. In this case, two separate modeling efforts using different model platforms show the same major result for the late summer-fall period – the reservoirs store heat and the river is cooler without them. See Bartholow et al. (2005), and the PacifiCorp modeling results summarized from a fish perspective by Dunsmoor and Huntington (2006). Documents pertaining the development of the PacifiCorp water quality model are included in the folder named: KR	modeling so that the prediction of 18 day shift could vary significantly from the 18 days. This unknown, but likely large, large range around the 18 days arises from model uncertainty and from year-specific conditions.

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			Water Quality Model. 5) From a biological standpoint I am far more concerned about the thermal consequences of the dams in the late summer and fall because this is when the system naturally cooled off, and the local species evolved under that template. Similarly, the local species evolved under mid-summer conditions that were very warm, with adverse conditions in the main stem. So while it can be said that water temperatures will worsen during mid-summer under dam removal, it can also be said that they are returning to a more natural condition for the Klamath River. 6) Finally, while this question was oriented towards coho, I note that the Panel's response was not coho-specific, and so I will point out that thermal results of dam removal for steelhead are quite positive e.g. see Figures 19-20 in Dunsmoor and Huntington (2006).	
98	Dunsmoor	38, 1st sentence on page	Wording issue – perhaps "occur" in the first line should be "occurring"? If not some other change is needed.	The report has been revised in response to this comment.
99	Dunsmoor	38, 2nd paragraph	Bradbury et al. (2004) documents similar results to Eilers et al. (2004). See filename: Bradbury_et_al_JOPL_history_recent_ limnological_changes_human_impacts_2004.pdf	This comment is noted.
100	Dunsmoor	37-39, Microcystis	First, see comment 2 above. Second, this discussion relies entirely on nutrient reduction to change the current problems with *Microcystis*. Kann (2006; filename: KannFinalYurokMsaeTechMemo2-3-06.pdf) concluded that the KHP reservoirs provided ideal habitat for *Microcystis*, where massive blooms exported large quantities downstream. Removing the dams will eliminate the habitat for *Microcystis* and eliminate the massive blooms and subsequent downstream	The report has been revised for clarification in response to this comment.

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			export of *Microcystis.*	
101	Dunsmoor	42, 1st full paragraph, and this section in general	See comments 3 & 17.5 above. Dunsmoor and Huntington (2006) concluded that dam removal would provide a net benefit to juvenile salmonid use of refugia (pgs 20-22, Appendix B, Table B13). Again I point out that high water temperature during summer in the main stem is a natural characteristic of the Klamath River. A key difference between the dams in and out alternatives is the variability in the thermal regime. Dam removal enables more effective use of thermal refugia and allows the river temperatures to respond to cold fronts, producing cool periods that could enable some movement, a pattern these species evolved with in this basin.	This comment is noted. The report has been revised in response to this comment. The Panel has added a statement regarding the benefit of temperature fluctuations.
102	Dunsmoor	51	In reference to #3, we call them resident *O. mykiss* now, but they're only resident because we blocked their access to the ocean with dams. Dunsmoor and Huntington (2006) conclude significant improvements in mainstem thermal regimes for steelhead will accompany dam removal, which is at odds with the last paragraph.	This comment is noted. The report has been revised for clarification in response to this and other comments.

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103	Dunsmoor	52, 1st full paragraph	Water quality in Upper Klamath Lake and Keno Reservoir is adverse during the summer and at times during fall. The following statements regarding life history refer to pgs 14-18 in Shaw et al. (1997; filename: Klamath R life stage periodicities chinook coho steelhead 1997.pdf). Winter steelhead would find no impediments to upstream migration related to water quality. A seasonal trap and haul will be in place as needed during fall, so fall steelhead will have some assistance migrating upstream during portions of their run. Link River Dam has a new state-of-the-art ladder, and ladder improvements are planned for Keno Dam.	This comment is noted. The Panel has provided their opinion regarding this matter in the final report.
104	Dunsmoor	54, 3rd paragraph, "In terms of…"	This sentence confuses me. Suitable habitat for anadromous salmonids is presently inaccessible above Iron Gate Dam – why reference Upper Klamath Lake here? If it is intended to apply to the dams out alternative, it is incorrect, since dam removal will enable fish (especially steelhead) access above Upper Klamath Lake.	The report has been revised in response to this comment.
105	Dunsmoor	54, last paragraph	With respect, saying that "the agencies appear to be relying upon being able to facilitate access to the upper basin with a lengthy trap-and-haul program if the fish cannot get there unaided" is simply unfair and inaccurate. Neither the agencies nor the other parties intend trap-and-haul to be the long term answer. The fish transport program is intended to facilitate re-introduction, and all parties share the goal of discontinuing the program as quickly as possible. And insofar as the species in question here are concerned, steelhead are least likely to need trap-and-haul to be successful. We are all, including the agencies, determined to be successful with restoration measures. The Panel has stated many times it lacks sufficient detail to judge these restoration actions. Fair enough, since we're in the process of building basin-wide restoration programs	The Panel responds that it is not clear what the agencies propose to do if the fish cannot "get there unaided". While the Panel applauds the efforts made by agencies to reduce conflict and to plan for change, the Panel is not in a position, with the information provided, to predict the likely effect on fish populations, either qualitatively or especially quantitatively (as the Panel were asked).

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			following the unprecedented effort we have all poured into getting these agreements in place. Similarly, there are no plans for downstream transport of juveniles – again, steelhead would be the species least likely to require such intervention. But clearly, such management decisions must necessarily flow from experience. The Panel should also consider that the agencies, tribes, states, and NGOs have been fighting tooth and nail in the FERC realm and elsewhere for the last decade to a produce a result for this basin that represents a full frontal assault on the ecosystem problems we face here. The detail may be lacking, but the aspirations and determination to succeed are clear.	
106	Dunsmoor	57, 2nd paragraph	Restoring proper sediment dynamics to the reach below Iron Gate may have another consequence not mentioned here. What role might the macroinvertebrate community dynamics associated with hydrology and substrate play? The polychaetes have invertebrate predators, and substrate and hydrology both affect invertebrate community dynamics. See Power et al. (2008; filename: Power_2008_EcolMono.pdf) for interesting work in the Eel River, a few drainages south of the Klamath.	The Panel cannot address this question with the available information, although the Panel is familiar with the Power's work.
107	Dunsmoor	57, 3rd paragraph	"Eutrophic" is the natural condition of Upper Klamath Lake – we are trying to address hypereutrophy, a big difference.	The report has been revised in response to this comment.
108	Dunsmoor	62, 1st paragraph under Discussion	For steelhead, there is simply nothing to stop them from moving through Keno Dam and Upper Klamath Lake if the adults arrive after the water quality improves. Far from certainty? Trout do it now, why would steelhead be unable? Thermal improvements resulting from dam removal in late summer and fall are not small, they are large, and biologically significant.	"After the water quality improves" is a time frame the Panel cannot ascertain with the available information.
109	Dennis Lynch	20,3	*"ensure effective use of peer review". "This element appears to be missing from some of the reviews of the reports provided to*	This comment is noted.

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			the Panel". Given the recent preparation of some reports, some reports may not have gone through all steps of the peer review process. The SD does have a process for review and peer review. The reports that the Panel received may have been in various stages of the review process. I believe the protocols for SD peer review include all of the major points made by the Panel including a selection of objective experts, and use of resolution documents to create a record of the review comments and adequacy of response. Peer reviewers are anonymous with respect to the comments but all individuals will be credited on a list of reviewers.	
110	Dennis Lynch	19,5, sect 3.1.1 and P. 22, Para 3, L 2	"There is no coho population dynamics model under active consideration at present, though one was developed for this project and then removed from Panel consideration." And "The Panel found it inexplicable that the life cycle model for coho, which had been provided initially to the Panel was withdrawn from our consideration just before the Panel meeting". The Coho Model report was not funded directly under the SD process. The Bureau of Reclamation has been funding development of this model for several years with Crammer and Associates. I believe an earlier version of this model is on the Crammer website; however, this earlier model only includes estimates of coho response with the dams in place. In 2010, Reclamation asked Crammer and Assoc to update this model for a dams in and dams out scenario. Reclamation, the	This comment is noted. The report has been revised in response to this comment. The wording has been changed in the report from "inexplicable" to "frustrated."

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			agency funding this new work, made an agency management decision to pull this new version of the Crammer Coho modeling report back from consideration by the expert panel to ensure that adequate science review had taken place so that Reclamation could stand behind the final report. It is Reclamation's prerogative and responsibility to not release a report that has not received all the review they feel is needed to make it the best report possible. Additional science review that Reclamation wants to obtain, and has not obtained up to this point, will be from other Federal Agency experts as well as from experts in the stakeholder community. Reclamation is now developing a plan to obtain those reviews and make any revisions to the coho modeling report, if warranted.	
111	Yurok Tribe	Pg i: par 1	Consideration of closely-related actions (such as restoration, flow management, etc) that are part of the KBRA is appropriate, however, it is beyond the scope of this panel to make judgments on the likelihood of implementation of the KBRA, or the potential effectiveness of KBRA implementation.	The Panel was presented with the KBRA as a set of actions, either unspecified or vague as to extent, and asked to make quantitative estimates as to the influence of Conditions without Dams and with KBRA. The uncertainty in extent, implementation, effectiveness, and content of the KBRA actions are central to any estimate of changes in coho or steelhead populations. It would have been irresponsible of the Panel to assume blindly that the goals of KBRA would be achieved without some consideration of the content of KBRA. Furthermore, based on the low specificity of the information provided, and Panel

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				members' experience with other restoration programs, the likelihood and degree of implementation bear heavily upon the likely outcomes with dams out and KBRA.
112	Yurok Tribe	Pg i: par 1	The question before the secretary and therefore the expert panel is primarily about dam removal, and is the result of carefully crafted language in the KHSA (section 3.1). The panel should retain the meaning and exact wording of the language in the KHSA. Suggest inserting KHSA language into the document, and deleting major sections of document relating to the KBRA. The two alternatives must be evaluated as presented, and the panel is out of place to insert evaluations as to the likelihood of obtaining funding for KBRA actions, efficacy of such actions, etc. [begin quote] *Based upon the record, environmental compliance and other actions described in Section 3.2, and in cooperation with the Secretary of Commerce and other Federal agencies as appropriate, the Secretary shall determine whether, in his judgment, the conditions of Section 3.3.4 have been satisfied, and whether, in his judgment, Facilities Removal (i) will advance restoration of the salmonid fisheries of the Klamath Basin, and (ii) is in the public interest, which includes but is not limited to consideration of potential impacts on affected local communities and Tribes.*	The Panel disagrees with this comment. See response comment 111. The Panel was charged to compare dams-in versus dams-out with KBRA, and the charge to the Panel was quite clear that the latter was to be considered as a package. The Panel then worked with the material provided. In order to answer the questions posed to the Panel, issues about the efficacy and implementation of KBRA must be considered.

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113	Yurok Tribe	ii, 3	The Panel reaches the following conclusion with regard to coho: "The benefits to coho salmon of Conditions without Dams and with KBRA are expected to be small…" The substance of the entire document leaves the reader with the view that dam removal and everything that would go with it would have, at most, only minor beneficial effects on coho. The extent of any positive effects, as the document describes, would be inconsequential in moving toward recovery. This view is put forth even though the Panel states repeatedly that significant uncertainty exists about potential effects and that too much is unknown in order to project effects on population performance. Given such uncertainty, what confidence should the reader have in the Panel's conclusion? We conclude, through our review of the Draft Report that the Panel's conclusion hinges primarily on four issues: 1. <u>That coho could not--or would not be allowed to—become established in the upper Klamath system upstream of Upper Klamath Lake(UKL).</u> The Panel assumed that the upper limit to future coho distribution would be Spencer Creek, based on the conclusion of Hamilton et al. (2005) that that was the upper historic extent of distribution. As we presented to the Panel on December 13 (see Lestelle's written comments submitted to the Panel), it is uncertain where the upper limit to historic distribution was, but that point does not need to limit the species future distribution. The Panel appears to have only allowed for the possibility of future natural recolonization, and the potential for colonizing to areas upstream of UKL was apparently waved away. Active introduction steps could be taken, however, which could facilitate the establishment of coho in the	The Panel revised the report to state more clearly that dams-in will continue the bad conditions into the future, and that dams-out with KBRA should be an improvement. However, the Panel maintains that given the uncertainties with dams-out and KBRA and the current state of the coho, expected responses by coho are likely to be small. Uncertainty is high in particular about whether coho could maintain populations upstream of Upper Klamath Lake, in the near or distant future. Much of the uncertainty hinges on whether water quality can be improved to the extent that some project proponents seem to believe. As stated elsewhere, the Panel is not so optimistic. At a more general level, the Panel's role was to provide their unbiased (with respect to project outcomes) expert opinion and evaluation about the science. Clearly, there are disagreements among the parties involved about the certainty of how dams-out with KBRA will benefit coho. Equally clearly, project proponents are enthusiastic about the project and therefore optimistic

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			upper basin. As noted in written comments submitted by L. Lestelle on behalf of the Yurok Tribe, thermal conditions of some of the upper watershed's streams (Wood River, Williamson River) could provide conditions to offset future effects of climate change. Huntington et al. (2006) describe streams in the upper basin that are well suited to support coho production. As noted our written comments, the distance of an adult migration to that area should not be prohibitive. Coho are known to migrate upstream far greater distances than this in other rivers. Passage through Link River is now quite possible, whereas it may have acted as a barrier historically (Logan and Markle 1993, citing Moyle 1976). The evidence suggests that if introduced coho could in fact return to the upper basin, then they could be the key to recovering the Upper Klamath coho population (as the TRT defined the basin's populations), especially in light of potential climate change. Such an event would also likely be very important to coho in the aggregate in the Klamath basin. Despite the presentation of this prospect to the Panel, the Panel made no comments at all on such a scenario—not even acknowledging the hypothesis. The Panel should address this hypothesis directly. If the Panel finds that an introduction of coho could not take hold in this area, then explicit reasons should be given. The Panel itself recognized the importance of explicitly stating hypotheses in the restoration/recovery program (see p. 18)—the Panel should state its competing hypothesis and the basis for such, with regard to the feasibility for establishing coho in the upper basin above UKL. 2. <u>An assumption that "most natural spawning" by coho</u>	about outcomes. The Panel necessarily had to filter out the optimism and consider only what is known or could reasonably be expected, given the available information. Thus, the conclusion of the Panel is that dams-out with KBRA will be an improvement but the magnitude of improvement is likely to be small for coho.

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			occurs in tributaries of the Klamath River downstream of Weitchpec at RM 43.5 (see pages 40 and 43). The significance of this assumption to the panel's logic appears to be that since most spawning occurs in the very lower end of the basin, then restoration activities and dam removal being considered are of little consequence to Klamath coho. This assumption will be shown (in comment no. 22) to be based on an erroneous inference drawn from Wallace (2004). It is an example of how something gets passed along in the literature without re-examination and is taken to be true. Evidence exists that a substantial amount of the basin's coho natural production originates upstream of Weitchpec—as addressed under comment no. 22. It also bears noting here that the Panel's consideration of effects on Klamath coho were always presented in the context of the aggregate Klamath population—giving little weight to population structure and the TRT's population delineations. Even allowing for uncertainty in population structure, the Panel's conclusion that the effects of dam removal on "Klamath coho" would be small says nothing about the possibility of very substantial benefits on a smaller portion of the aggregate population, i.e., on the population of the interior region of the basin (such as the Upper Klamath population as defined by the TRT). Recovery is to be measured by changes in performance at the population level—not at the level of the basin-wide aggregate Klamath population. Allowing coho access to cold water areas above the current location of Iron Gate Dam (including but not limited to spring influenced areas under Copco Reservoir, J.C. Boyle springs, Spencer Creek, and potentially the numerous	The Panel agrees that coho could colonize the upper basin assuming there are still fish available to colonize that area. The key question is will they successfully complete their lifecycle with high enough survival in both freshwater and the ocean to produce a viable population. This comment is noted. The report was revised to make it clear that Yurok Tribe disagrees with Wallace. Please note that the Panel was simply trying to state where in the basin coho spawn: mainstem versus tributaries; lower areas versus upper areas. The Panel was provided little information on spawning distribution of coho. The Panel agrees with this perspective, as it is easy to be too focused on abundance only. The Panel discussed this in the report.

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			coldwater areas above UKL would directly increase the abundance, productivity, spatial structure, and diversity (life history and genetic); all considered to be primary parameters for determining the viability of West Coast salmon stocks. These effects would be beneficial to coho despite the possibility of competition and predation, which are present under any management scenario. 3. <u>That the KBRA actions would generally be ineffective at improving coho performance to any significant degree.</u> The KBRA is a legal agreement and was never intended to be a comprehensive plan. There is uncertainty with regard to how the KBRA will be implemented, just as there is uncertainty if the KBRA is not implemented. At present time, the KBRA restoration and monitoring plans are being drafted which will give more certainty to future restoration actions. This is the basis for evaluating recovery actions for salmon and steelhead populations across the Pacific Northwest. Action planning is occurring at a very intensive level in numerous watersheds and the Klamath is no different. For example, the research that is currently underway by the Yurok and Karuk tribes on coho ecology is yielding very substantive information on where and what kinds of habitat actions should be implemented, by highlighting the importance of Lower Klamath/estuary habitats for overwinter rearing of coho from throughout the Basin. This has already led to the construction of off-channel ponds and implementation of large woody debris projects in these areas. Actions targeted at specific issues that negatively affect survival should have significant positive effects in improving population	The report has been revised in response to this comment. Text was added to summary conclusions to recognize benefits of broadened spatial structure, genetic diversity, and life history options with dams out, even if numeric response is small; qualifications that may limit positive responses still hold.

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			performance, this is why agencies are investing tremendous sums of money in improving habitat conditions in numerous river systems across the Northwest. Experience in other basins, such as Grande Ronde (NOAA Fisheries Draft 2010), has shown that with appropriately targeted actions productivity, abundance, diversity, and spatial structure can be improved significantly. This is most evident for populations that are most depressed, since relief in those cases can have very substantive effects on population productivity, which in turn also increases abundance and adds to life history diversity and spatial structure. Similar results have been published for recovery planning for many other populations—of which Mr. Lestelle has been involved in many using the EDT model (e.g., Carmichael and Taylor 2009; Thompson et al. 2010) we find that the Panel has not shown why these same levels of effects are not possible in the case of Klamath coho. Of course there are uncertainties—and projected effects may not materialize as projected, but that is the process for learning and improving future actions. This is still a nascent science, and as the panel has noted, dam removal should be viewed as a grand experiment with some aspects of the outcome more certain than others. Large-scale salmonid restoration efforts are occurring throughout the Pacific Northwest, and the situation is no different in the Klamath. 4. <u>That *C. shasta* effects will not be materially improved for coho and that this is a sort of trump card.</u> While the Panel correctly identifies that this is a critical uncertainty, and seems to recognize that the potential exists for significant improvements (see page 57), in the	The report has been revised in response to this comment. Specifically, text about *C. shasta* was

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			end the Panel seems to disregard the very significant effects that could occur as a result of dam removal. The association between dams and prevalence of C. shasta, is clear in our view, throughout the Pacific Northwest, even recognizing that there is still much that is not known. If *C. shasta* was significantly ameliorated, then our conclusion would be that very substantive benefits would accrue to coho despite the other uncertainties. As with the issue involving uncertainty in the KBRA actions, the Panel seems to take the most conservative view in the face of uncertainty, and fails to recognize that there is significant uncertainty if the dams stay in (i.e. disease problem can worsen to the point of causing localized extinction). The Panel should explicitly state its hypothesis regarding the potential effects of dam removal on C. shasta effects. If the Panel cannot formulate a specific hypothesis, then it should recognize that a wide range of results could occur—from no change to very significant positive effects. Uncertainty is not a reason to conclude that marginal positive effects are most likely. These four issues suggest that effects on coho of the dam removal and KBRA actions could potentially be tremendously positive.	revised in the report. However, the Panel found the future conditions with regard to *C. shasta* to be a critical uncertainty. That is, if things work out well, conditions for coho will be better. If not, they will not. The main point here is not to <u>assume</u> that one or the other outcome is most likely. The principal role of science in such a situation is to eliminate arguments by reducing uncertainty. Thus, in preparation for a multi-billion dollar restoration, the most parsimonious approach would demand that the key uncertainties be reduced to the greatest extent practicable before the "Big Experiment" is undertaken. To do otherwise would be irresponsible.
114	Yurok Tribe	iv, "ecosystem function"	The expert panel has asserted that there is inadequate information to ascertain whether dam removal plus implementation of the KBRA will positively affect ecosystem function in the Klamath River, and thus be of minimal benefit to coho salmon. However, a large body of literature, discussed more fully below, identifies the fundamental ways that dams alter and disrupt a river's physical and ecological systems. Even	The Panel is well aware of the available information on effects of dams on rivers. In the section on ecosystem function the Panel distinguish between effects of dam removal and consequent re-connection of habitat to the river,

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			if Klamath-specific information is not available to the panel's satisfaction, the weight of this body of literature regarding the effects of dams is such that it appears to be reasonable to advance the hypothesis that removal of dams on a river will begin to reverse the profound effects that the dams themselves have caused. In its report, the expert Panel failed to recognize the ways in which the dams disrupt normative function and processes of the Klamath River and thus how removing dams would restore normative riverine processes and functions in the Klamath River. Further, the panel failed to link coho and steelhead population abundance and stability to these normative functions and processes. The need to restore normative ecological function, in part through dam removal, in the Klamath River is especially urgent in the face of climate change. Without such restoration actions, losses in the abundance and resilience of natural coho and steelhead in the are expected. To adequately weigh the potential importance of dam removal to the Klamath ecosystem, one needs to consider the key linkages that drive riverine ecosystems, and how dams disrupt them. Physical, chemical, and biological patterns and processes in river systems are structurally and functionally linked (Minshall 1988, Ligone et al 1995). At the landscape scale, the river corridor is linked to longitudinal gradients of water and material transport (Vannote et al. 1980), lateral gradients of riparian systems (Naiman et al. 2005), and vertical gradients of groundwater-surface water exchanges (Ward and Stanford 1982). On the whole, river systems such as the Klamath function as linked systems in which ecosystem-level processes in downstream	and the effects of KBRA and other actions (or outcomes of dam removal) on other aspects of ecosystem function besides hydrology and geomorphology. In other words, simply removing dams, while a key ingredient for restoration, does not imply that ecosystem function will be restored.

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			areas are linked to those in upstream areas (Vannote et al. 1980; Minshall et al. 1985). Recognizing these linkages within the river system and its surrounding landscape provides a foundation for understanding how ranges in variation in these patterns and processes affect river ecosystems (Stanford et al. 1996; Hauer et al. 2003), and gives a basis for analyzing the effect of dam removal to the Klamath River. A river ecosystem with "normative"—i.e., resembling the natural state though with some modification—variations in these patterns can usually maintain physical and biotic processes sufficiently to support the indigenous species and life histories that evolved there (Liss et al. 2000; Bunn and Arthington 2003). Dams and their impoundments can so severely disrupt the interactive physical and biotic processes (e.g., hydrologic, organic production, animal movements) relative to the natural state as to threaten indigenous species and life histories (Stanford et al. 1996, Ligon et al 1995). The widely accepted Serial Discontinuity Concept (SDC) views man-made impoundments, and the dams that form them, as major disruptors of the natural biochemical and biophysical gradients along rivers (Ward and Stanford 1982; Naiman et al. 2005). According to the SDC, dams result in upstream or downstream shifts in biotic and abiotic patterns and processes—the direction and extent of shift depending on the nature of the river, species assemblages, and the spatial position of the dams along the river. Predicting the effects of dams on the natural patterns and processes can be difficult due to the highly complex interactions involved. But the effects most often involve the following (Ward and Stanford 1982; Stanford et al. 1996; Bunn and Arthington 2002; Naiman et al. 2005): alterations to the natural flow, thermal, trophic, and sediment transport regimes; altered life	

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			histories of native species due to the regime shifts; proliferation of certain taxa due to the regime shifts (which can include pathogens and parasitic species); losses in connectivity and fragmentation of habitats (longitudinally, laterally, and vertically); disruptions to the movements of native species due to losses in connectivity; invasions of exotics; imposition of equilibrium conditions on prior existing non-equilibria communities; conversion of lotic habitats to lentic water bodies that fundamentally do not function as naturally occurring lake and wetland systems. These disruptions caused by dams pose special challenges to watershed management and species recovery efforts as climate changes occur. Since individual aquatic and riparian plant and animal species are adapted to specific temperature ranges, climate changes are expected to shift potential geographic ranges of species to the north or to higher elevations (Naiman et al. 2005). The ability of species to move to more suitable geographic ranges and elevations will depend on the suitability of habitats as well as the ability to move along dispersal or migration corridors (Poff et al. 2002). Within a river system, dams can block access to cooler thermal regimes, thereby preventing species to adjust their distributions with climate change; the Klamath River is a prime example of dams blocking access to thermal refugia. The dams on the mainstem Klamath River have had profound effects on the abiotic and biotic patterns and processes in the river basin. Changes to all the functions and processes noted above have occurred result of these dams. While there can be no doubt that declines in salmon populations are due to the cumulative effects of many factors over the past century, it is certain that the dams have played a central part in these losses.	

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			Without a return to more normative riverine conditions—especially as the influences of climate change grow—recovery and rebuilding of the Klamath salmon and steelhead populations will become more difficult. The hypothesis that dam removal will begin to reverse the severe physical and ecological effects as noted above is reasonable and well-supported.	
114	Yurok Tribe	iv, "ecosystem function"	The expert panel has asserted that there is inadequate information to ascertain whether dam removal plus implementation of the KBRA will positively affect ecosystem function in the Klamath River, and thus be of minimal benefit to coho salmon. However, a large body of literature, discussed more fully below, identifies the fundamental ways that dams alter and disrupt a river's physical and ecological systems. Even if Klamath-specific information is not available to the panel's satisfaction, the weight of this body of literature regarding the effects of dams is such that it appears to be reasonable to advance the hypothesis that removal of dams on a river will begin to reverse the profound effects that the dams themselves have caused. In its report, the expert Panel failed to recognize the ways in which the dams disrupt normative function and processes of the Klamath River and thus how removing dams would restore normative riverine processes and functions in the Klamath River. Further, the panel failed to link coho and steelhead population abundance and stability to these normative functions and processes. The need to restore normative ecological function, in part through dam removal, in the Klamath River is especially urgent	The Panel is quite aware of the extensive body of literature on both the structure of physical, chemical, and biological linkages within a drainage basin and on the effects of dams on aquatic ecosystems elsewhere. The literature review is thus unnecessary. However, it is the charge of the Panel to assess *how and to what extent* that recorded experience elsewhere pertains to *the specific case of the Klamath and its fish community in their current state and their regional and likely future context*. It would not serve the purposes of the review's clients if the Panel were to uncritically import references to all the good things that might have happened where dams have been removed (or more generally, all the bad things that have happened where dams have

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			in the face of climate change. Without such restoration actions, losses in the abundance and resilience of natural coho and steelhead in the are expected. To adequately weigh the potential importance of dam removal to the Klamath ecosystem, one needs to consider the key linkages that drive riverine ecosystems, and how dams disrupt them. Physical, chemical, and biological patterns and processes in river systems are structurally and functionally linked (Minshall 1988, Ligone et al 1995). At the landscape scale, the river corridor is linked to longitudinal gradients of water and material transport (Vannote et al. 1980), lateral gradients of riparian systems (Naiman et al. 2005), and vertical gradients of groundwater-surface water exchanges (Ward and Stanford 1982). On the whole, river systems such as the Klamath function as linked systems in which ecosystem-level processes in downstream areas are linked to those in upstream areas (Vannote et al. 1980; Minshall et al. 1985). Recognizing these linkages within the river system and its surrounding landscape provides a foundation for understanding how ranges in variation in these patterns and processes affect river ecosystems (Stanford et al. 1996; Hauer et al. 2003), and gives a basis for analyzing the effect of dam removal to the Klamath River. A river ecosystem with "normative"—i.e., resembling the natural state though with some modification—variations in these patterns can usually maintain physical and biotic processes sufficiently to support the indigenous species and life histories that evolved there (Liss et al. 2000; Bunn and Arthington 2003). Dams and their impoundments can so severely disrupt the interactive physical and biotic processes (e.g., hydrologic, organic production, animal movements) relative to the natural state as to threaten indigenous species and life histories	been built). The Panel was asked to assess the particular circumstance of the Klamath River, where four dams are located downstream of a warm, hypereutrophic lake, fed by heavily impacted tributaries, in which there are as yet vaguely conceived plans for implementation of restoration activities. In this situation, the Panel concluded that there is a surprising lack of specificity in the information provided as a basis for answering the questions posed to the Panel, and a surprising lack of initiative in taking advantage of opportunities for experimentation with restoration activities in the Klamath basin.

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			(Stanford et al. 1996, Ligon et al 1995). The widely accepted Serial Discontinuity Concept (SDC) views man-made impoundments, and the dams that form them, as major disruptors of the natural biochemical and biophysical gradients along rivers (Ward and Stanford 1982; Naiman et al. 2005). According to the SDC, dams result in upstream or downstream shifts in biotic and abiotic patterns and processes—the direction and extent of shift depending on the nature of the river, species assemblages, and the spatial position of the dams along the river. Predicting the effects of dams on the natural patterns and processes can be difficult due to the highly complex interactions involved. But the effects most often involve the following (Ward and Stanford 1982; Stanford et al. 1996; Bunn and Arthington 2002; Naiman et al. 2005): alterations to the natural flow, thermal, trophic, and sediment transport regimes; altered life histories of native species due to the regime shifts; proliferation of certain taxa due to the regime shifts (which can include pathogens and parasitic species); losses in connectivity and fragmentation of habitats (longitudinally, laterally, and vertically); disruptions to the movements of native species due to losses in connectivity; invasions of exotics; imposition of equilibrium conditions on prior existing non-equilibria communities; conversion of lotic habitats to lentic water bodies that fundamentally do not function as naturally occurring lake and wetland systems. These disruptions caused by dams pose special challenges to watershed management and species recovery efforts as climate changes occur. Since individual aquatic and riparian plant and animal species are adapted to specific temperature ranges, climate changes are expected to shift potential geographic ranges of species to the north or to higher elevations (Naiman et	

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			al. 2005). The ability of species to move to more suitable geographic ranges and elevations will depend on the suitability of habitats as well as the ability to move along dispersal or migration corridors (Poff et al. 2002). Within a river system, dams can block access to cooler thermal regimes, thereby preventing species to adjust their distributions with climate change; the Klamath River is a prime example of dams blocking access to thermal refugia. The dams on the mainstem Klamath River have had profound effects on the abiotic and biotic patterns and processes in the river basin. Changes to all the functions and processes noted above have occurred result of these dams. While there can be no doubt that declines in salmon populations are due to the cumulative effects of many factors over the past century, it is certain that the dams have played a central part in these losses. Without a return to more normative riverine conditions—especially as the influences of climate change grow—recovery and rebuilding of the Klamath salmon and steelhead populations will become more difficult. The hypothesis that dam removal will begin to reverse the severe physical and ecological effects as noted above is reasonable and well-supported.	
115	Yurok Tribe	iv; “ecosystem function”	The panel states that uncertainty with regard to the outcome of the KBRA is a primary reason it cannot state that benefits from such actions will accrue. Yet no such consideration is given to the uncertainties with regard to the no action alternative. For example, in several locations, the Panel expresses concern with groundwater pumping that might occur because of the KBRA, and nowhere in the document does it express a similar concern with regard to the no action, despite the fact that water	The first sentence on this topic in the draft report (Table ES-1, Ecosystem Function, Conditions with Dams) begins "The information available is insufficient to answer this question, …". The Panel does not see how this expresses confidence in the success of no-action outcomes.

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			deliveries are interrupted in much more unpredictable ways through BiOp implementation than through KBRA implementation. Furthermore, KBRA has safeguards and limits on groundwater pumping (Section 15.2.4 of KBRA), when no such safeguards exist for no action (especially in CA where groundwater use is unregulated). The disparity between concern expressed for KBRA uncertainties and the contrasting confidence the Panel places on the implementation and success of no-action outcomes (i.e. TMDL's fully realized, etc); must be addressed in the Panel's revised report.	The report has been revised in response to this comment. Text was clarified to explain that the purpose of the report was to compare the two alternatives, not evaluate one or the other.
116	Yurok Tribe	1, 3	Panel report needs to clearly state how peer review will occur and how peer review comments will be handled.	This comment is noted. The commenter should note that is the function of this response and amendments to the report. The draft report was released for both public review and an independent peer review. Note that all (over 400) comments received on the draft report have been considered and responded to by the Panel.
117	Yurok Tribe	P. 10	Assumptions: While TMDL, TMDL implementation plans, and CA fisheries restoration plans are assumed to be fully implemented, the KBRA is not afforded that assumption. This is not a proper framework for analysis. Credible analysis cannot cast doubt on implementation of one restoration program (KBRA) while assuming full and perfect implementation of other programs such as TMDL. Solution: assume full implementation of all aspects of each alternative, re-do analyses to reflect these	See response to comment 116. Such an assumption would fly in the face of Panel members' experience with restoration programs elsewhere.

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			assumptions.	
118	Yurok Tribe	17, 2	The Panel states that the questions are "not answerable with a satisfactory degree of precision or confidence." It is not evident from the text what would constitute a satisfactory level of confidence. This potentially means that the conclusions of the panel are so fraught with uncertainty that they have little value for their intended purpose. The Panel then goes on to list six obstacles to "drawing convincing conclusions"—suggesting to us that the conclusions can only be taken to be anything but convincing. In light of these uncertainties, We believe that the Panel could serve the process much better by identifying conditions whereby effects on the species could be significant—then to do the same whereby benefits would only be marginal. It would be helpful if the Panel would explicitly address this question: What would be required for the dam removal alternative to indeed have a very substantive benefit to the species? Alternatively, what conditions would keep benefits limited to low levels? By addressing such questions, the Panel could help make clear its operating hypotheses regarding levels of effects. This could also help identify necessary studies that are mentioned on p. 18.	The report has been revised in response to this comment. The offending text has been replaced with wording that explains the Panel's intent. It is the Panel's opinion that the suggestion to identify conditions where benefits would be "significant" or only "marginal" would go well beyond the charge of the Panel. As it stands, the report explains the reasons for the Panel's conclusions.
119	Yurok Tribe	P. 17, bullet 5	Similar uncertainties exist for TMDL implementation, state restoration programs, etc, yet uncertainty is only expressed for KBRA elements. This is an incorrect frame of reference. For example, there are considerable uncertainties as to how landowners will react to the current BiOp, and there are serious questions as to whether the current BiOp is biologically or politically stable.	The Panel recognizes that uncertainty abounds, and not only in the environment itself. However, the Panel focused on the key contrasts between the two alternatives, one of which is KBRA. Thus, the uncertainty in KBRA discussed in the report is central to the Panel's ability to analyze the difference between the alternatives.

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120	Yurok Tribe	18, 3-6	Topics are well stated. These would provide the foundation for pursuing the action in a way to garner success in recovery.	This comment is noted.
121	Yurok Tribe	18, 7	Here the Panel further underscores the uncertainty surrounding its task and addressing the questions. The Panel suggests here that it was unable to consider all of the necessary information that might be available. Most of the questions being asked of the Panel were not seeking a quantitative response – of course the Panel did not have the tools or the time for such responses. Instead, the Panel was typically asked, based on their expert opinion, to explain how they would expect to the effects of the proposed alternatives to differ relative to particular parameters. One would expect the panel to draw on the large body of literature concerning physical and ecological effects of dams to rivers, the large body of literature concerning the effectiveness of different approaches to freshwater habitat restoration, and the body of peer-reviewed scientific literature regarding reintroduction efforts and other dam removal efforts throughout the Pacific Northwest. This type of experience and analysis was conspicuously absent.	The Panel was less constrained by the availability of information from elsewhere than by the information specific to the Klamath. Although we were provided with over 2GB of documents, our report makes clear that there were major information gaps specific to this system that precluded facile answers based on other experience. For example, few if any of the examples of dam removal elsewhere include issues of hypereutrophication upstream of the removed dams, or of severe problems with water quality and disease. Thus, with the severely limited time available, the Panel chose to focus on the local issues.
122	Yurok Tribe	18, 8 and p. 19, para 2	The Panel states the presentations on December 13 "did not convey an effective, comprehensive view of the project as a whole." This statement echoes our own observation. On page 19, the Panel gives ideas for how the assessment can be improved, and we believe that a dialogue is much more useful than a one-time review.	This comment is noted.
123	Yurok Tribe	20, 5 and 22, 3	The Panel notes that "there is no coho population dynamics	This comment is noted.

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			model under active consideration at present." The Panel also found it inexplicable that the life cycle model for coho, which had been provided initially to the Panel, was withdrawn from their consideration just before the Panel meeting. As the panel noted in its report: "A model can serve a variety of legitimate purposes, depending on the degree of scrutiny it has passed." The coho model presented to the panel in fact had little or no scrutiny, thus was withdrawn by its authors, because it was not ready for use in evaluation of the questions put before the Panel. It is inappropriate for the panel to discuss that model in its evaluation. We agree that conceptual and quantitative models may eventually fill a critical role as we move forward with removing the dams and restoring the Klamath Basin; especially in regard to identifying limiting factors and prioritizing restoration activities.	
124	Yurok Tribe	23, 4	The Panel identifies two elements in answering the questions: direction of effect and magnitude of effect. Regarding the second element, the Panel states that "the second element is accessible only through use of population and life cycle models." The Panel goes on to state its reasoning in a way that we generally agree with—(see for example, Lestelle et al. 1996; Mobrand et al. 1997; Lestelle et al. 2004; Blair et al. 2009; Thompson et al. 2009). Given the complexity of coho and steelhead life histories in a basin like the Klamath, that the Panel cannot reach a quantitative assessment of the effects of dam removal given the current information. We believe the Panel has made a very strong case as to why it should not attempt to identify a magnitude of effect with the time and information it had available to it. **Yet the panel did so anyway.**	The Panel disagrees with this comment. The Panel did not state a quantitative response, unless one somehow views "small" as quantitative. Second, the questions charged to the Panel asked for quantitative answers, which we refrained from. Third, a project of this magnitude should, in the Panel's opinion, better address some of the key uncertainties or have a specific plan for addressing the key uncertainties. Interestingly, the next comment supports this – research is underway for a

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				conceptual model.
125	Yurok Tribe	24, 2	Research currently underway by the Yurok and Karuk tribes—funded by the USBOR—is aimed at producing a conceptual model that shows the relative importance of different life stages and geographic areas in the basin to the overall coho production in the basin. The conceptual model will be aimed at illustrating how life history patterns differ in the basin and how different habitats—including the mainstem corridor—are used in the life cycle of the species. A template for this was provided in Lestelle's written comments submitted to the Panel on December 13 on behalf of the Yurok Tribe. This conceptual model is not meant to be quantitative at this point—only to illustrate how we see the basin being used by different life stages. It illustrates, however, that any quantitative modeling that endeavors to assess coho performance and potential responses to actions will need to take into account the complexities of both life histories and the river system.	This comment is noted.
126	Yurok Tribe	24, 4-6	The discussion was difficult to follow. Can it be clarified? For example: how much coho habitat would need to be provided in the Project reach for the Panel to consider it to be more than than a "small extension". Spencer Creek alone would provide a substantial increase in quality coho habitat relative to current conditions in the Klamath Basin.	The report has been revised for clarification in response to this comment.
127	Yurok Tribe	28, 2-3, then 29, 1-3	The Panel identified what seems to be a contradiction between material in Hetrick et al. (2009) and Fortune et al. (1966). The Panel goes on to try to sort out some of the observations of Huntington et al. (2006) with regard to how much functional habitat exists in upstream of UKL. Our reading of the Panel's views here is that it seems to conclude that not much suitable	The Panel confronted the differences between the two estimates of habitat potential, which summaries provided to the Panel had ignored. This could have been done more productively by the

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			habitat is available upstream of UKL. This does not square with the findings of Huntington et al (2006), please address this inconsistency. We are concerned that this may be a reason why the panel did not address coho response upstream of Upper Klamath Lake; please respond. On the whole, the evidence shows that significant amounts of good habitat exists upstream of UKL for both species, and KBRA restoration activities would serve to further improve it.	technical staffs who wrote the recent summaries, using their local knowledge. The Panel also pointed out that the recent summaries (Huntington et al. 2006; Hetrick et al. 2009) were vague and apparently based on remote observations. The Panel outlined the nature of the concerns about the availability and quality of habitat, and the meaning of "potential habitat". The degree of these uncertainties and the fact that they were not addressed by the technical agencies submitting material to the Panel are the reasons why considerable uncertainty exists about the degree to which KBRA is likely to have an effect on populations upstream of Upper Klamath Lake. As described in the report, the availability of suitable habitat for coho salmon above Upper Klamath Lake does by no means guarantee successful establishment of coho salmon above Upper Klamath Lake.
128	Yurok Tribe	37	Regarding Microcystus and algae bloom dynamics, please see comments appended at end of this document regarding specific water quality aspects.	The report has been revised in response to this and other comments. Changes have been made on the topic of *Microcystis*.

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129	Yurok Tribe	37, 3-5	Our reading of the text here is that the Panel cannot conclude anything about the effect of temperature changes on the performance of coho and steelhead in the mainstem corridor due to dam removal due to uncertainties in the current temperature modeling. However, we believe that the temperature modeling showed several features that would benefit salmonids: 1) Although average temperatures are higher in the spring time, the dams also make the temperature near Iron Gate Dam much less variable and responsive to local meteorology; thus there are fewer low temperature weather-caused events that juveniles can take advantage of 2) Although the Panel may be uncertain about the specifics of the calibration of the temperature model, the predicted decrease in fall mainstem Klamath temperatures near Iron Gate Dam is of sufficient magnitude (5-9C) that it is highly unlikely that increased thermal variation will cause fish to actually experience higher temperatures than without dams. Calibration issues aside, these inferences alone can point the panel to some supportable hypotheses regarding the effects of dam removal to temperatures and ultimately to fish. This is further supported by the fact that the temperatures would be returned to a more normative state, and thus [end of comment]	The Panel respects the opinions expressed in this comment, but was charged with formulating their own opinions. The degree to which changes in temperature will affect coho can be resolved with additional modeling and data collection.
130	Yurok Tribe	39, 4	As noted above, the modeling is clear in showing that without dams, water temperatures, while being higher for the late spring period (not summer as stated), will be much more responsive to meteorology, and thus much more variable. The panel must	The report has been revised in response to this comment. The data we reviewed and presented in the discussion indicated higher

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			think hard about the implications that short periods of lower temperatures (not simply 24 hour diel variations) will have to fish migrating between refugial areas. Furthermore, the effects of temperatures must be considered in tandem with access to areas of significant and stable colder water. Under current conditions, high temperatures are teamed with lack of access to cold water (Jenny, Fall, Spencer Creeks, JC Boyle springs). This is very significant to coho and steelhead. Essentially, without dams the river is in a "warm headwaters" condition instead of a "cold headwaters" condition. The panel must address this issue.	temperatures through mid-July under the dams- out alternative. The Panel added more info on the variability of temperatures. The cold headwater issue raised here is discussed under the refugia question in the final report.
131	Yurok Tribe	40, 1	The Panel has the view that most natural coho production in the basin occurs downstream of Weitchpec at RM 43.5, citing Wallace (2004) in Stillwater (2010). As noted earlier in comment no. 1, such a view is unrelated to how actions might affect coho upstream of Weitchpec that are considered by the TRT to be different populations than those downstream. Regardless, it is important to recognize how Wallace (2004) arrived at this conclusion and that it is erroneous. Wallace's report was a final analysis of many years of sampling in the Klamath River estuary using beach seines and electrofishing gear to assess annual variation in the hatchery/natural composition of juvenile salmon that passed through this area. The focus was on chinook but data were also collected on coho, though numbers of coho captured were generally relatively small. The exact language of Wallace's conclusion regarding coho is as follows: *"Most of the coho in NSA's catches were hatchery origin fish, primarily from TRH (Table 10.) However, natural origin yearling coho were a significant part of NSA's catch comprising 27 to 66% of the catch (Table 10). The natural coho component of screw*	The report has been revised in response to this comment. The Panel thanks this commenter for the detailed information. The Panel searched for data such as this that provides some indication of spawner distribution. The text has been modified accordingly and the Wallace and Stillwater references were removed.

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			trap catches on the mainstem Klamath and Trinity Rivers was usually lower than the natural component in the estuary (Weskamp and Voight 2001; Weskamp et al. 1998; USFWS 1999; USFWS unpublished data). This suggests that most of the natural coho production in the Klamath-Trinity basin occurs in the lower Klamath River tributaries downstream of the screwtraps and Trinity River." NSA refers to the Natural Stocks Assessment Project conducted by CDFG. TRH refers to Trinity Hatchery. Wallace is referring to catch composition data (for yearling coho) collected at screw traps operated by USFWS at Big Bar on the mainstem Klamath River (RM 50) and on the lower Trinity River (USFWS 1999), as well as to screw trap data collected on the mainstem Klamath River at RM 10.5, just above the estuary (Weskamp and Voight 2001; Weskamp et al. 1998). Thus, Wallace's conclusion was not with respect to how much spawning occurred downstream of Weitchpec (which would include the entirety of the Trinity as well as tributaries below the Trinity) but rather with respect to how much occurred downstream of the Trinity River, i.e., just in lower Klamath tributaries below the Trinity. Wallace was apparently of the view that the majority of natural spawning for the entire Klamath basin occurred in the relatively few tributaries downstream of the Trinity River! He reached this conclusion by comparing hatchery/natural coho compositions in the screw traps to what he observed in the estuary. He estimated that the natural component percent was higher in the estuary than what was found in the screw traps, therefore most yearling coho, he concluded, were coming from areas downstream of the Trinity, and therefore, most spawning was occurring downstream of the Trinity. Two of the reports he cited were prepared by Yurok biologists and covered sampling they	

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performed (Weskamp and Voight 2001; Weskamp et al. 1998). Their results for coho yearlings are shown below in Table 1.

Table 1. Numbers of hatchery and natural coho captured in screw traps in the lower Klamath and Trinity rivers.

Sampling year	River	Locati on RM	No. 1+ coho	% TRH	% IGH	% Natural
1997	Klamath	10.5	123	72%	5%	22%
1998	Klamath	10.5	230	83%	5%	12%
1998	Trinity	0.5	851	91%		9%
1999	Trinity	0.5	744	97%		3%

IGH refers to Iron Gate Hatchery.

In contrast, Wallace estimated that between 27-66% of the estuary catches were comprised of natural coho, causing him to reach his conclusion. His reasoning did not consider two very important matters. First, he failed to take into account the differences in migration rates between hatchery and natural coho in the very lower ends (including the river mouth estuary) of these kinds of rivers. Hatchery coho smolts are typically much larger than their wild counterparts, as was found by Wallace in his sampling (Table 2).

Table 2. Fork lengths (mm) of coho smolts captured in the upper and lower portions of the Klamath estuary as reported in Wallace (2004).

		TRH		IGH		Natural	
Year	Area	No.	FL	No.	FL	No.	FL
2002	Upper	89	200±32	2	216±19	12	135±30
2002	Lower	23	186±23	1	156	34	132±13
2001	Upper	105	181±22	7	174±25	39	146±24
2001	Lower	57	185±23	26	167±17	46	141±14
2000	Upper	72	163±13	6	167±14	44	130±14
2000	Lower	17	170±12	1	171	25	134±13
1999	Both	Sampling started after coho emigration					
1998	Both	Sampling started after coho emigration					

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			TRH smolts were typically 30-50 mm larger than natural fish, a very large amount for coho smolts. This usually results in a much faster migration rate for hatchery smolts, as has been consistently observed in over 30 years of sampling coho smolt migration rates in the lower Queets River on the Washington Coasts (this river has a similar river mouth estuary as that in the Klamath)(Lestelle and Curtright 1988; Quinault Indian Nation unpublished data). In the Queets River, hatchery coho smolts typically show a fast, short duration migration through the lower river and its river mouth estuary. They generally do not linger there and move directly through it. Also, because they are released from the hatchery facility in a very short window, their migration pattern is very uniform. In contrast, natural coho smolts, which are smaller than hatchery smolts there, show much more protracted, diverse, and slower migration patterns (Lestelle and Curtright 1988; Lestelle 2006). The natural fish appear to linger somewhat in the lower river with some amount of accumulation occurring prior to exiting the area. The effect of these differences in migration patterns, as Lestelle and Curtright (1988) found, is that the capture rate of natural smolts using gear like beach seines deployed in consistent, regular time intervals throughout the migration season is much higher than it is for hatchery smolts. In fact, these recognized differences in capture rates between hatchery and natural coho smolts using beach seines have been an integral component of the procedure used to estimate natural coho smolt yields in the Queets River over the past 30 years (Lestelle 2009). Lestelle and Curtright (1988) also found that while catch efficiencies of beach seines differed between coho smolt groups depending on their migration rates (such as between hatchery and natural fish), catch efficiency by a fixed trap (such as screw traps and scoop traps) did not differ between groups. In the latter case,	

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			migration rate had no effect on catch efficiency (in this case, fish are simply moving past a fixed site so that whether they are moving fast or slow has no effect on rate of capture). These differences in catch efficiencies between hatchery and natural smolts with gear types is, in our opinion, the major reason that Wallace observed differences in the hatchery/wild compositions in his catches. Another factor that would cause differences in catch compositions is where smolts were actually smolting from. Research being conducted by the Yurok and Karuk tribes is finding that an overwintering redistribution may be of very significant magnitude in the Klamath basin, with some juveniles redistributing great distances downstream in fall and early winter (Soto et al. 2008; Hillemeier et al. 2009). Major overwintering areas occur in close proximity to the river mouth estuary. Hence, this type of redistribution would be expected to greatly confound the sort of comparison that Wallace was attempting. His conclusion about relative distribution of spawning would be greatly mistaken. It bears noting that Wallace's reasoning would lead one to conclude that most spawning was actually occurring downstream of RM 10.5—but that is very clearly an absurd notion when one considers the distributions of young-of-the-year and spawners that are being found in the basin (Yurok and Karuk unpublished data; report in progress) and even a simple understanding of the basin. Finally, the only estimates of natural spawner distribution in the basin that we are aware of is found in Ackerman et al. (2006). Those authors used a variety of methods—all documented in their report—in an attempt to estimate the distribution of natural spawners. They estimated numbers of natural spawners for all areas of the basin in each of four years (2001-2004). In	

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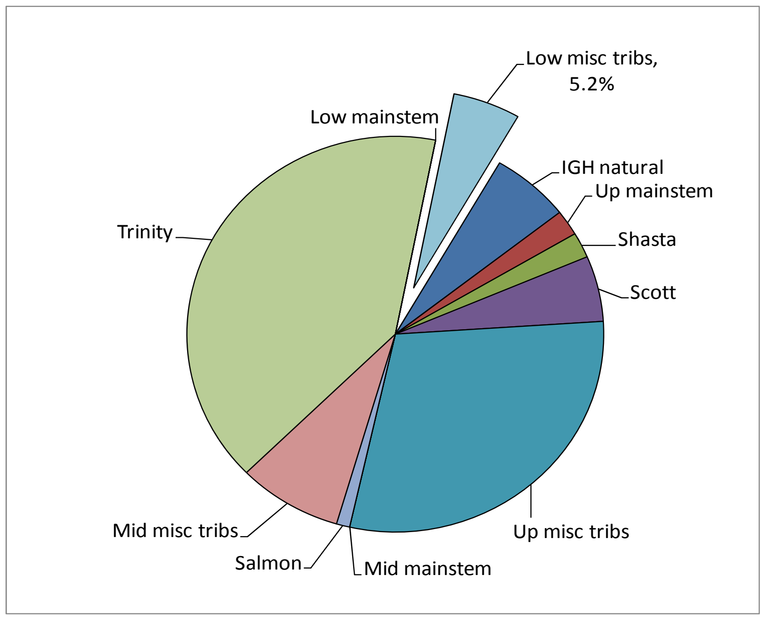
			some cases they reported the estimates as a range. We compiled their estimates and derived an average percentage of the spawning for the four years, using the midpoint of ranges when they were used (Figure 1). This results in an estimate of about 5% occurring in the basin downstream of the Trinity River, in contrast to Wallace's conclusion of "most" occurring there. About 45% of all natural spawning was estimated to occur downstream of Weitchpec (i.e., the combined amount in the Trinity and downstream of the Trinity). **Figure 1. Estimated average distribution of natural coho spawners in the Klamath basin in 2001-2004 as derived by Ackerman et al. (2006).**  We conclude that all of the evidence shows that Wallace's conclusion is flawed—any use of it by the Panel is a mistake.	

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			Therefore, most natural spawning does not occur in tributaries of the Klamath River downsteam of Weitchpec at RM 43.5, and thus natural coho production is NOT beyond substantial influence of the dam removals.	
132	Yurok Tribe	40, 2	Change in mainstem flow should only relate to the migration of adults in the mainstem, since entry of adults in to the spawning tributaries is probably primarily related to fall rains, as noted by Sutton (2007). Regarding the citation by Sutton, it is not listed in the literature cited section of the Panel's report.	The report has been revised for clarification in response to this comment.
133	Yurok Tribe	41, 3	In this para, the Panel is paraphrasing written material that L. Lestelle submitted to the Panel on behalf of the Yurok Tribe. The Panel has introduced some changes from what was submitted that are significant. Note the following: In mid para, the sentence reads: "As temperature declines in September, most juvenile coho generally remain associated with the localized areas." The original statement read as follows: "As water temperatures decline in September, it is likely that most juvenile coho generally remain associated with the localized areas in which they had been rearing if conditions are suitable." Mr. Lestelle went on to explain that it would be likely that fish would disperse from refugia if high densities existed and food and space were in short supply. We believe this an important aspect since the juveniles should respond in a way that would maximize their survival. With regard to rearing in the mainstem river, the Panel added a phrase that cannot be attributed to Mr. Lestelle. The Panel's text reads: "*but the benefits of rearing in the mainstem versus tributaries of the Klamath River is unknown*." The Yurok Tribe's submittal suggests something entirely different than this which	The report has been revised for clarification in response to this comment.

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			we believe to be more accurate than the Panel's interpretation—the text reads: "*It is important to recognize that juvenile coho that find suitable habitat in large streams, such as along the margins of mainstem rivers, tend to grow faster than those rearing in small streams (Cederholm and Scarlett 1982). Faster growth and larger size promotes higher overwinter survival (Quinn and Peterson 1996); when rapid growth occurs in the fall in Northern California streams, it has been shown to produce very large yearling smolts (Nielsen 1994*)." In fact, substantial amounts of data have been collected as part of the on-going research project that shows very clearly that juvenile coho that are using the mainstem corridor in the Klamath River are usually larger than those that rear in the smaller tributaries away from the mainstem corridor (report in progress). This fact alone means that it is likely that fish that successfully rear in the mainstem corridor survive better in subsequent life stages than those that rear entirely in the small tributaries.	
134	Yurok Tribe	42, 2	Mid para sentence reads: "Growth potential of mainstem margin habitats may be greater than that of tributaries (Cederholm and Scarlett 1982 in Lestelle 2010), but this result likely varies from watershed to watershed and this has not been evaluated in the Klamath Basin." As noted in the previous comment, the data for the Klamath demonstrate that juveniles associated with the mainstem corridor are generally larger than those that rear in the smaller tributaries. This is a common pattern in other watersheds in the Pacific Northwest.	The report has been revised for clarification in response to this comment.
135	Yurok Tribe	42, 3	End of the para reads: "But the cooler water with the dams out may reduce growth potential of fish residing there during fall." Our view on this matter is that in the range of temperatures that have been projected, growth would not be negatively affected. It might be improved. Still, the Panel's interpretation would seem	This comment is noted. The Panel agrees that lower fall temperature would probably have a somewhat small effect.

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			to have merit at some point in the season. On the whole, though, considering the possibility of an earlier entry back into the mainstem, the effect should be substantially positive.	
136	Yurok Tribe	42, 4	This question of tributary versus mainstem spawning is irrelevant. The important question is not how much spawning occurs in each area. The question of importance is how the mainstem is used—and actually the mainstem corridor since the two are so closely associated with one another—over the entirety of the life cycle. The major redistributions that occur mean that fish that spawn in a tributary may in fact be much more affected by what happens in the mainstem than what happens in the tributary. See the conceptual model of how coho use the Clearwater watershed that Lestelle presented as part of his written comments on behalf of the Yurok Tribe.	This comment is noted. The questions were provided by agencies. Mainstem spawning above Iron Gate Dam was covered by the habitat access question.
137	Yurok Tribe	43, 3	End of para, the Panel repeats the matter of how little (though mistaken) spawning occurs in areas to be mainly affected by dam removal. We believe this to be in error. See comment no. 22 above.	The report has been revised for clarification in response to this comment. The text was corrected and reference to Wallace removed.
138	Yurok Tribe	43, 4	Regarding the possibility of spawning habitat being a limiting factor to coho in the basin, this matter appears to not be an issue in the basin. It is likely that factors operating during summer and winter are much more important to coho performance in the basin. Other salmonid stocks do not appear to be spawning limited (i.e. fall-run Chinook).	The report has been revised for clarification in response to this comment.
139	Yurok Tribe	45, 2-3 46, 1-4	Here, the Panel concludes with regard to coho access to areas upstream of IGD with dam removal: "Population responses of coho salmon are expected to be marginal. The logic train in the Panel's argument is lacking—it seems it is based solely on an assumption that utilization could only extend to Spencer Creek.	The Panel provides several factors that the Panel believes will determine the success of coho salmon populations in the newly-accessible habitats, including re-

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			Furthermore, the Panel seems to be assuming that only natural colonization would need to occur (p. 46). The panel must consider other possibilities besides passive reintroduction. This matter needs to be addressed more clearly by the Panel. The Panel also references Table 6 that summarizes estimated population responses to extended access garnered from materials available to it. The para that references this table seems to suggest that the materials available to the Panel show that coho response would only be marginal. This conclusion does not appear to square with the materials presented to the panel. The panel apparently disregarded written material submitted on behalf of the Yurok Tribe by Lestelle which stated: "*When considering the very real potential for re-introducing/introducing coho to areas upstream of UKL, the payoff to population viability is expected to be far greater than just considering a range extension to Spencer Creek. In my view, establishing coho in the area upstream of UKL offers the very best prospect—and a realistic one—for offsetting any potential effects of climate change that are being projected for the Klamath basin*." This same para by the Panel (p. 45 para 3) repeats the idea that the Panel is not making any quantitative projection of effects—but then in the same sentence the Panel states that any positive responses by coho would only be marginal. This appears to be contradictory and internally inconsistent.	introduction.
140	Yurok Tribe	45, 4	The report states that "*it is reasonable to hypothesize that new populations of coho and steelhead upstream of Iron Gate Dam, once established, should help "spread the risk" in terms of long-term viability of salmon and steehead in the face of climate change (McElhandy et al. 2000)….However, the effects of predation and competition for thermally benign habitat do not*	The Panel agrees with this comment. Coho and steelhead and resident fish will 'sort it out'; and coho and steelhead will likely be able to survive. But the Panel were asked for more than to simply

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			appear to have been considered in the projections of extending the range of anadromous fish into the Upper Basin". We agree that it is possible that predation and competition will have an effect upon the coho and steelhead in the Upper Klamath, as they do everywhere that fish survive in a natural ecosystem. However, coho and steelhead were able to sort this out and survive in the Upper Basin before the dams were constructed; it is a reasonable hypothesis to assume that they would once again be able to survive in the Upper Basin.	determine whether these species will survive in the newly accessible habitats. Whether they will be able to establish significant populations will require that additional conditions be met – each with uncertainty.
141	Yurok Tribe	46,1	The report states that "survival of emigrating steelhead smolts and coho smolts is currently low (based on few steelhead hatchery returns versus releases and tagging of coho smolts;" Great caution should be exercised when relating the survival of IGH steelhead smolts to what expected survival rates are for wild fish, because residualization of hatchery steelhead may be a contributing factor. Relatively low survival of coho smolts in the Beeman paper may be attributable to problems with C. Shasta – as we noted in comments related to the disease issue, we believe that the scientific evidence shows that removal of the dams would be very likely to substantially diminish juvenile disease issues. Furthermore, the coho ecology study being conducted by the Yurok and Karuk Tribes indicate that a component of the coho and steelhead populations exhibit life history traits that alleviate potentially low survival rates during spring emigrations. Numerous coho that have been PIT tagged by the Karuk Tribe during the summer/fall are later recovered in Lower Klamath (near the estuary) tributaries in off-channel habitats over-wintering. We have noted this non-natal over-winter rearing by	The report has been revised for clarification in response to this comment.

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			coho and steelhead in the Lower Klamath (Gale 2008, Soto et al. 2008, Hillemeier et al 2009). These fish not only exhibit substantial growth compared to fish rearing in inland tributaries, but they also forego the potential disease issues currently experienced by those fish that emigrate as smolts during the spring months. These fish that overwinter in the Lower Klamath (near the estuary) only need to emigrate a few miles as smolts before they are in the ocean.	
142	Yurok Tribe	46, 2	The Panel states that materials provided to it give "numerous" examples of reasons that population responses to new habitat may only be modest, at best. Yet we cannot find these numerous examples in the Panel's report. We had presented a line of reasoning that suggests that population response—with active introduction steps—could be substantive, and perhaps be the key to recovery of an upper Klamath population. Please address this in the Panel Report.	This comment is noted.
143	Yurok Tribe	46, 5	The Panel states at the end of the para that it is only considering introduction scenarios for coho upstream to Spencer Creek. Please address possible measures to introduce coho to the areas upstream of UKL.	The Panel believes that success of coho salmon in the newly-accessible habitats above Iron Gate Dam, (including above Upper Klamath Lake, if established) will be contingent upon the suite of factors identified in the report.
144	Yurok Tribe	48, 1	As noted above, if one considers active introduction of coho into the areas upstream of UKL, then groundwater-dominated habitats would likely be much more important to coho than steelhead.	The report has been revised for clarification in response to this comment.
145	Yurok Tribe	50, 2	The Panel states at the end of the para: "*In the Klamath Basin, emigration of fry from tributaries to the mainstem may be a*	The Panel agrees with this comment. The report has been

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			losing tactic for coho salmon, because the likelihood of survival under current conditions in the mainstem is low unless fish find suitable refugia (NRC 2004)." Based on information in other systems, this would appear to be a reasonable hypothesis, however, when one considers the very significant degraded conditions in both the Shasta and Scott rivers, another view on this matter emerges. Without this tactic, prospects for survival can be very poor, because conditions within those tributaries are even worse (Scott River goes dry, Shasta River reaches 28C). The tactic of redistribution to cold water refugia along the mainstem corridor appears to offer better prospects for survival in at least some cases. This entire matter is still under investigation as part of the on-going research and the story has not yet been written. The Panel should defer judgment on this at this time.	revised for clarification in response to this comment.
146	Yurok Tribe	50, 3	The Panel begins this para by saying that "*Significant benefits to productivity of coho salmon in tributaries could be realized in several ways by the KBRA.*" The para continues by giving some examples as to how this could happen. The para ends with this statement: "However, the extent of any such improvements is unclear from the description of KBRA provided to the Panel, so the magnitude of improvements in survival cannot be estimated." Yet the Panel goes on to estimate the magnitude of these benefits to be minimal. This matter in comment no. 1. It baffles us that while the Panel accepts the notion that significant benefits could indeed be accrued—but since the actions have not been better defined (by the KBRA, which is a legal document, not a "Restoration Plan" which is currently being developed per the KBRA), then the Panel must somehow assume that benefits would only be marginal, which is what is assumed in the end. We strongly suggest that the Panel should jettison this conclusion in its final draft so that	See response to comment 115. The report has been revised but the conclusion remains: it is unclear whether the KBRA will be able to improve habitat for coho to the point where the population can successfully complete its life cycle above Upper Klamath Lake. The chief uncertainty has to do with water quality, but there are many others. Given vague information about the extent of the KBRA actions, and given the Panel members' skepticism about the likely success of water quality improvements in particular, a reasonable conclusion is that

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			the document is internally consistent and so that the potential benefits to coho are clearly acknowledged. The panel must also acknowledge that there are considerable uncertainties involved in no action. Biological Opinions can change, and there is no coherent restoration or science plan at all, absent KBRA. At least the KBRA puts a process into place for getting there with regard to restoration and recovery.	improvements to the coho population under dams-out/KBRA will be small in comparison with the dams-in alternative.
147	Yurok Tribe	50, 4-6	Why is this entire section only aimed at steelhead?	The question put to the Panel was targeted at steelhead. Coho are dealt with elsewhere in the report.
148	Yurok Tribe	53, 3-4 and rest of section	See discussion under page vi "ecosystem function" in regards to ecosystem function and the contradiction between the Panel's conclusions when compared to the body of literature regarding the effects of dams to riverine systems. In regards to food, the Panel seems to punt. It refers to materials submitted to it as stating that habitat above UKL appears to be good for steelhead (the same can be said for coho). But the Panel says that the materials said nothing about food; the Panel states that food is very important. In those geographic areas that are still in relatively good condition, i.e., intact, food can be reasonably be assumed to be of very suitable quantity and quality. That is not say that a study aimed at this matter would not be useful—but to raise questions here about its suitability is entirely unfounded. Where ecosystem processes are intact, fish food availability—given the thermal and flow regimes that exist there—should be of high quality. Furthermore, it is not clear why the Panel would raise an uncertainties about competition for food and space with resident *O. mykiss*. Competition between aquatic species occurs in every river of the Pacific Northwest.	The Panel agrees that partitioning may allow co-existence of species or multiple life history types, but disagrees that all life histories will be necessarily expressed. It is equally reasonable to hypothesize that the productive, spring-fed tribs of Upper Klamath Lake will primarily produce non-anadromous *O. mykiss* – the tradeoffs of migration may simply not pay off given favorable conditions in these areas.

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			The native species evolved under such conditions—and partitioned the resources in a way that enabled life histories to be expressed that supported the species in co-existence (numerous papers could be cited here). Why is this issue any different when re-opening habitats that have been closed to anadromous species for decades?	
149	Yurok Tribe	55, 2	Myxozoan Fish Diseases The Draft Expert Panel Report noted "Three potential consequences for disease prevalence in coho may arise from removal of the dams and an improvement of adult passage by Keno Dam under the KBRA. These potential consequences are: reduction in the alternate host (polychaetes), reduction in infection by reducing salmon carcasses, and spreading of the disease above the dams." (Draft Coho/Steelhead Panel Report pg. 56). The first two potential consequences listed above are likely to both occur under the dam removal/KBRA option as opposed to a likely worsening under status quo. The last potential consequence is technically not true since the disease already exists above the dams, and the risk of serious consequences of spreading the Chinook salmon genotype (type II) is low because it would only influence Chinook salmon and there is not the conditions necessary to duplicate a hyper-infectious zone with the dams and hatchery removed (i.e. overlap of highly favored polychaete habitat with highly infected adult salmon carcass and favored planktonic food and increased habitat and flow stability). Thus based on this logic and the list of three possible consequences above, the rational conclusion is that disease impacts are likely to be significantly reduced under dams out/KBRA with a smaller probability of some localized increased	The information available on the parasites and their hosts is rich and extensive. The Panel heard the strong, even passionate opinions expressed to the effect that the proposed action would eliminate the disease problem. However, the Panel was asked to make its own judgment, based on the available information. We do not argue that removing the dams would have no effect. Rather, we argue that it would be very useful as well as feasible to know more about the likely outcomes in advance. If the proposed action is to be based on science rather than belief, investigations to reduce these uncertainties are warranted.

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			disease impacts in the upper basin in some years. This conclusion is in contradiction to implications of the overall conclusion cited in the executive summary that "removal of dams can result in reductions and increases in disease incidence" and that the "information available is insufficient to determine the net effects". The scientific information to date clearly supports the conclusion that the most likely outcome of dam removal/KBRA is a substantial and persistent reduction in C. shasta infection and mortality rates that will benefit all salmonid species, including steelhead and coho salmon, even with uncertainties taken in account. Failure to accurately evaluate and present this critical information regarding myxozoan disease dynamics in the Klamath River basin could fatally undermine the accuracy of any qualitative or quantitative evaluations of the likely outcomes of dam removal and implementation of KBRA. There are a number of fisheries experts whom have worked on the myxozoan disease issues on the Klamath River that support the conclusion that scientific data to date, including from other river basins, strongly points towards substantial reductions in disease problems with the removal of the dams and hatchery in question. More specific information follows. 1) The parasites and their hosts are all native to the mainstem Klamath River but polychaetes are absent from all its tributaries (with the possible exception of the Trinity River which has conflicting evidence but is generally non-infectious for C. shasta) most likely due to the evolutionary bio-geography of polychaetes (ancient dispersal from inland seas) and their extremely poor upstream dispersal abilities (Stocking and Bartholomew 2007). Coho and Chinook salmon stocks in the Klamath River basin are highly resistant to C. shasta (which is	

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			believed to be far more pathogenic than P. minibicornis although dual infections are the norm), but are less resistant than steelhead. While steelhead is more resistant and has demonstrated lower mortality rates, it is false to claim that their observed mortality rates are also not a serious problem. 2) Patchy but hyper dense populations of these polychaetes have been indentified within the mainstem Klamath River, particularly between the Shasta and Scott rivers, resulting in a hyper infectious zone from just above the Shasta River to approximately Seiad Valley (Stocking et al. 2006; Stocking and Bartholomew 2007), although juvenile (True et al. 2010) and adult (Foott et al. 2009) fish below the confluence of the Trinity River can also become infected at lower levels. 3) Polychaetes benefit from stable habitats with Fine Particulate Organic Matter (FPOM). While they have been observed in riffles facing into swift current, they are susceptible to scour, displacement, and burial mortality from high flow events (Bartholomew and Foott 2010). They have also been observed underneath large cobble and other areas that provide substantial refuge from high flow events (Josh Strange's personal observations). 4) Polychaetes are able to eat a wide variety of food sources from suspended and benthic detritus and micro-organisms, but lipid rich diatoms are an especially valuable food source (Bartholomew and Foott 2010). Polychaetes also eat blue-green algae such as Microcystis aeruginaso but the digestibility is unknown. Both diatoms and microcystis proliferate in the project reservoirs and dam removal is expected to reduce this food source, in	

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			particular microcystis (also containing a powerful liver poison), which benefits from high nutrients but also requires stratified, low velocity waters of reservoir and lakes to form blooms (Huisman et al. 2004). Microcystis has consistently been absent from the river upon entry to Copco reservoir but has been exceptional high upon exiting Copco and Iron Gate reservoirs (Kann 2006; Kann and Asarian 2006). 5) There are multiple genotypes of C. shasta, which in the Klamath River generally correspond to a specific salmonid species. The Chinook salmon genotype has only been found downstream of Iron Gate Dam where as the coho and steelhead genotypes are found throughout the river including above UKL (see Bartholomew and Foott 2010). An implication of this finding is that reintroduction of anadromous salmonids to the upper basin above Iron Gate Dam and UKL, whether passive or active, would not introduce novel genotypes to these areas with the exception of the Chinook salmon genotype that would only have the potential to impact newly establishing populations of Chinook salmon that are already resistant. 6) Klamath River Chinook salmon are able to resist infection below a certain threshold of actinospore dose but their defense is overwhelmed at concentrations above approximately 10 spores per liter (see discussions in Bartholomew and Foott 2010), and their resistance is obviously lowered by a variety of potentially synergistic stressors. Infection rates and severity are dose dependent, which is a function of actinospore abundance, flow volume, and duration of exposure. Actinospore abundance is a function of polychaete abundance,	

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			polychaetes infection rates and severity, and actinospore transport dynamics (which are neutrally buoyant). Polychaetes infection rates tend to be low (<10%) based on available data (Stocking and Bartholomew 2007), and these infection rates are controlled primarily by myxospore abundance and dispersion. Myxospores can be produced by both infected juvenile and adult salmonids but the vast majority of mature infectious myxospores appear to be produced by highly infected individual adults wherein myxospores mature after host death (pre-spawn mortality or natural senescence after spawning) and are released as the carcass decays (Foot et al. 2009). Myxospores appear to be negatively buoyant and their life span does not appear to extend from one spawning season to the next, leading to the conclusion that reduction in adult infection rates and severity could have rapid benefits in terms of reduced myxospore production and subsequent polychaete infection rates and severity. Decreased polychaete infection rates and severity would in turn decrease the number of actinospores to infected adult salmonids returning to spawn, creating a beneficial feedback cycle from the perspective of juvenile anadromous fish survival. A pilot study led by Josh Strange, Scott Foott, and Jerri Bartholomew tested carcass removal in Bogus Creek for the purpose of determining if carcass removal could be an effective measure for reducing myxospore concentrations (Bartholomew et al. 2009). The results of this study concluded that carcass removal is not a viable strategy because it would likely be ineffectual due to the need to remove a very high percentage of carcasses in addition to logistical and ecological problems.	

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			7) There are no known predators that specialize in eating polychaetes and biological and chemical controls have been deemed speculative, ineffectual, or too costly in terms of unintended consequences. The C. shasta collaborative management team, of which the author is a member, developed and ranked a list of all possible management actions that could reduce disease morality of juvenile salmonids in the Klamath River, including research and monitoring plans which are under implementation. Of these, the only plausible action with a reasonable probability of significant benefits was high flow releases sufficient to scour, displace, and/or bury polychaete colonies. Multiple lines of evidence suggest flow in the range of 5,000 to 6,000 cfs in the vicinity of Iron Gate Dam are necessary to produce desired velocities to produce significant polychaete mortality (see citations in Bartholomew and Foott 2010), in particular disturbing the relatively instable habitats on FPOM/sandy pool and eddy bottoms that have been proliferating with phenomenal densities of polychaetes since the last flooding event in the winter of 2005/2006 (authors personal observations; Figure 1 and 2). The problem with this approach is that project reservoirs lack not only large capacity storage but also release capabilities sufficient to reach the above specie flow threshold unless a natural spill event is already occurring. Small spill events in the range of 3,000 cfs occur more frequently (every three to five years approximately), which creates an opportunity to increase penstock releases briefly to achieve the target flow threshold. The only reservoir with sufficient storage capacity to affect an artificial flow release of this magnitude is UKL (Link River Dam). Under status quo	

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			conditions, however, there is no management structure or avenue in place to allow for this type of flow management and PacifiCorp is resistant to undertake any non-mandated operational changes that could affect power generation (gravel augmentation is not beneficial to aiding polychaete mortality without these or higher flows). Specifically, PacifiCorp actively manages project reservoir to always avoid spills if at all possible, which has reduced the frequency of small tot moderate spill events and thereby contributing to polychaete habitat stability. In other words, with status quo the only management action with a reasonable probability of significantly reducing polychaete abundance (at least for a few years), and thereby actinospore abundance, is artificial flooding flows but the management structures in place under status quo are an impediment to implementing such an action that cannot be assumed will change. With dam removal and implementation of the KBRA, however, there will be management structures in place to allow for the type of flexible flow strategies discussed above and the remaining dams will have no power generating capacity thus removing any incentive to prevent spill events to maximize power generation. Dam removal and implementation the KBRA has the other significant benefits of dispersing spawning adult salmonids, and thereby myxospores, and reducing polychaete habitat stability and high quality food resources. 8) While there are still unknowns in regards to these parasites' lifecycle, ecology in the river, and prognosis of infected fish, the information discussed above demonstrates that there is a reasonable level of certainty about many major aspects of this disease problem. The	

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			hypothesis best supported by current information is that the hyper-infectious zone is created by the overlap of the highest polychaete densities (exacerbated by dam related habitat stabilization and food resource augmentation from reservoir plankton) with the highest numbers of adult salmon carcasses in the Klamath River (exacerbated by migratory blockage from the dams and production from Iron Gate Hatchery). This hypothesis also leads to the prediction that dam removal and phasing out of hatchery production at Iron Gate Hatchery alone would provide major reductions in C. shasta mortality among juvenile salmonids. The increasing numbers of stressors on juvenile and adult salmonids also contributes to the problem of reduced disease resistance (e.g. microcystin, high pH and free ammonia, pesticides, elevated water temperatures and nutrients, habitat degradation, reduced flows during periods of rearing and out-migration, multiple parasite infections, etc). Dam removal and KBRA is anticipated to improve or eliminate several of these stressor conditions, especially over the 50 year horizon, where as status quo would most likely see a worsening of several of these stressors over the 50 year horizon. 9) A quantitative, epidemiology model for C. shasta is currently under development by Adam Ray and Jerri Bartholomew of Oregon State University but is not yet functional (Figure 2). In lieu of and complementary to a quantitative model, conceptual models and an effects matrix are useful for evaluating alternative hypothesis and for reducing scientific uncertainty about anticipated, probable, plausible, and unlikely outcomes of dam removal and implementation of the KBRA versus status quo. A conceptual model is shown in Figure 3, which	

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			allows for evaluating the hypothesis that disease conditions will be significantly improved under dams out/KBRA compared to status quo. Of particular importance to note is the positive feedback loop created by elevated numbers of polycheates. These produce hyper abundance of actinospores which then infect returning adults. These adults then produce high numbers of myxospores conveniently concentrated at the top of the area of high polychaete abundance; therefore the cycle repeats resulting in increased polychaete infection levels and actinospore abundance. Of course there will be annual variation and stochastic events but the overall trend predicted over a 50 year horizon is alarming given current disease levels and projected climate change. Conversely, removing dams and implementing the KBRA is predicted, based on the mathematics implied by the conceptual model, to create a negative feedback loop between actinospores and myxospores. While it is plausible that localized, smaller hot spots for polychaete abundance and infection could be created above the site of Iron Gate Dam, there is not the same quality and quantity of polychaete or spawning habitat in the vicinity of Keno Dam nor will there be a hatchery built there. This hypothesis is also supported by an effects matrix, which lists the most likely outcome for each major C. shasta life cycle factor without ranking (Table 1). This matrix shows the consistent improvements anticipated under dams out/ KBRA compared with status quo. Other important but non- C. shasta life cycle related factors include stressors such as temperature, microcystis, and free ammonia, which all have a mix of potential outcomes under the two	

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			scenarios but with no certain negative disease implications. Whether the expert panel endorses this or any other potential hypothesis regarding C. shasta outcomes based on their expertise, it is crucial to deal with uncertainty with the appropriate scientific rigor by listing and discussing the likely implications for fish disease under plausible outcomes under differing hypothesis. For example, the hypothesis presented herein, which is well supported, could very likely result in major reductions in fish disease mortality and is one of the few possible avenues for increasing freshwater survival by several factors; thereby resulting in sustainably greater adult returns in addition to any gains from new accessible habitat and KBRA specific restoration activities in currently accessible habitat. It is also important to remember that, while the current disease hyper infectious zone extended to Seiad Valley, there are still substantial infection rates to the population as far downstream as the Salmon and Trinity Rivers in some years. These infections that would be minimized by reducing polychaete populations and concentrated myxospore production upstream (e.g. 10-20%; True et al. 2010). 10) It is important to note this hypothesis is consistent with the conclusions reached in the analysis of likely outcomes of dam removal and implementation of the KBRA conducted by the US Fish and Wildlife Service (Hetrick et al. 2010), which was reviewed by Scott Foott and Jerri Bartholomew and endorsed by an independent reviewer. The conclusions from the Executive Summary are quoted below along with the reviewer's comments with bold font	

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			added for emphasis: *Hetrick et al. (2010) -* *"Fish Health* *Our analyses of the potential effects of implementing the KBRA and removal of the PacifiCorp Project dams was conducted using disease incidence and outmigrant fish trapping data and a review of the current literature. We relied extensively on recent studies conducted by Dr. Jerri Bartholomew and her colleagues at Oregon State University and Dr. Scott Foott and staff of the Service's California/Nevada Fish Health Center. Dr.'s Bartholomew and Foott also provided specific text for, and extensively reviewed the Fish Health section of this report.* *Fish diseases are widespread in the mainstem Klamath River during certain time periods and have been shown to adversely affect freshwater abundance of Chinook and coho salmon. In recent years, the Service, working collaboratively with its University, Tribal, and Agency partners, has documented high infection rates in emigrating juvenile Chinook and coho salmon, primarily by one or both myxozoan parasites – Ceratomyxa shasta, and Parvicapsula minibicornis. Fish health studies conducted from 1995 to present have consistently documented high infection incidence (up to 44% of natural origin juvenile fall Chinook salmon) in the Klamath River during the spring and summer. Abnormally high infection prevalence within the native salmon population indicates that a host-parasite imbalance exists below IGD.*	

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			Polychaete worms, the alternate host for C. shasta, and P. minibicornis, are found throughout the mainstem Klamath River but are most prevalent in low velocity areas such as runs, pools, and riffle edge habitats, and inflow zones to reservoirs. Inflow zones of Klamath River reservoirs have exceptionally high densities of polychaetes, which is consistent with published literature. Converting the existing reservoir complex to a riverine system will eliminate these densely colonized areas. *The KBRA provides flexibility to manage flows to respond to real-time climatic and biological conditions that will create variability in flows and resulting habitat conditions and reestablish natural instability and disturbance of microhabitats preferred by polychaetes. Disturbance of polychaete habitats is anticipated to reduce the abundance of polychaete populations and may reduce infection rates within remaining polychaete colonies.* *Stable, monotypic, nutrient- and diatom-rich flows that occur below IGD provide an optimal environment for production of filter-feeding benthic invertebrates like polychaete worms. Fluctuating flows that mimic, albeit to a lesser degree, conditions experienced under a natural flow regime, will eliminate the monotypic stable flow conditions in which polychaetes are known to proliferate.* *The greater thermal diversity that will be experienced following removal of the Klamath River dams and reservoirs is likely to result in greater*	

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			invertebrate diversity and less favorable environmental conditions for production and survival of a single species such as the polychaete worms. Executive Summary *Removal of the PacifiCorp Project dams is likely to alter the distribution of myxospores, an intermediate life stage of myxozoan parasites released from salmonids, by dispersing adult spawning salmon and resident trout found below IGD. The fish passage barrier created by IGD and the adjacent Iron Gate Fish Hatchery have concentrated the density of spawning adult salmon in the IGD to Scott River reach, thereby exacerbating release of infectious myxospores within this reach. The greater abundance of myxospores released by dense concentrations of spawning salmon within this reach results in higher infection rates in polychaetes, which proliferate in this relatively stable hydrologic reach.* *Removal of PacifiCorp Project dams would facilitate the occurrence of higher peak flows, restoration of mid-sized (gravel) sediment input below IGD, and result in variable flows that could intermittently scour and desiccate polychaete colonies and their habitats, resulting in reduced actinospore loads the following spring.* *Reviewer -* *"Fish Health* *The compilation identifies the parasite Ichthyophthirius and the bacterial disease columnariasis (Flavobacterium columnare) as important factors*	

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			affecting survival of upstream migrating adult salmonids. The myosporidians Ceratomyxa shasta and Parvicapsula minibicornis are likewise identified as key factors reducing survival of juvenile salmonids. *While all of these organisms are believed to be endemic to the area, altered water quality parameters have clearly exacerbated their adverse impacts. The compilation appropriately points to anticipated fish survival benefits associated with improved juvenile and adult fish health resulting from increased flows, reduced temperatures, and reduced reservoir areas. These benefits are likely to be substantial as predicted based on water management experiences in other river systems such as the Rogue and Willamette."* (NOTE: tables and figures at end of comment matrix)	
150	Yurok Tribe	58, 4-5	Consideration should be given to using the IGH facility in a greater way to ensure genetic conservation of the existing resources in the area encompassed by the boundaries given by the TRT for the Upper Klamath coho population, as well as for the Shasta and Scott populations.	This comment is noted. The Panel was not given information on how Iron Gate Hatchery might be changed or used as a conservation hatchery. The Panel was only asked to examine the two alternatives, i.e., dam removal and removal of the hatchery after 8 years.
151	Yurok Tribe	61, 4	Overharvest of Klamath Basin coho is not an issue: harvest by river fisheries is well under 10%. Moreover, ocean fisheries on coho salmon off the coast of California have been eliminated since the early 1990's and impacts off the Oregon coast are limited to catch and release mortality during limited fisheries	The report has been revised for clarification in response to this comment.

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			that target mass-marked hatchery stocks.	
152	Yurok Tribe	64, 2	This para deals with the effectiveness of KBRA actions again. We have addressed it elsewhere, particularly under comment no. 1. If these actions are well designed and directed, then positive effects would be very substantive on all of the VSP parameters. In particular, productivity would be first affected, which in turn would enhance abundance, diversity, and spatial structure. Although there are uncertainties associated with the KBRA, it is unclear how the Panel concluded that a focused, ecosystem based restoration program, large-scale dam removal, and significant water quality improvements would fail to help coho. And, as stated elsewhere in these comments, the Panel failed to give equal consideration to the uncertainties associated with status quo, including worsening conditions on the river, or how water delivery interruptions cause by the current BiOp might cause groundwater use increases.	To reiterate from earlier responses, the Panel lacks the optimism of some of the proponents of this project, and has tried to examine the issues in the light of the information actually available, including experience from other restoration programs. For example, the Panel does not expect KBRA/dams out to result in "significant" improvements in water quality in Upper Klamath Lake. If the project proponents had a cogent argument for why the project would result in a larger benefit to coho than the Panel expects, they could have presented a formal, written document outlining the arguments and providing a firm, quantitative basis for the assertions about habitat improvements. The Panel saw no such document in the 2+ GB it was provided.
153	Yurok Tribe	65, entire section	We have addressed this elsewhere in our comments, particularly in comments no. 1 and 22. The Panel’s conclusion essentially says that any freshwater-based restoration plan is doomed to failure due to uncertainties inherent to large-scale restoration	This comment is noted. The Panel's conclusion does not say what this commenter suggests.

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			efforts and the overwhelming influence of marine survival issues. We have not given up on our goal of restoring Klamath Basin coho to harvestable populations, and we conclude that best course of action is a well directed and conceived restoration effort, which would be greatly enhanced with the addition of dam removal and active reintroduction of coho to the upper basin above UKL. See our written comments submitted on December 13 by L. Lestelle. We believe this approach is inherently ecosystem-based, because coho are but one of many species addressed through the KBRA and the removal of the Klamath Dams.	
154	W. Tinniswood	ii, 1 Under (1)	The amount of coho habitat above Iron Gate Dam was determined to be 58 miles in the project reach not including the habitat under the reservoirs by a group of experts and confirmed as factual during the ALJ hearing with PacifiCorp in 2006 (Judge Mckenna 2006). The results of this case are below: "USFWS/NMFS ISSUE 7: Whether access to habitat within the Project would benefit coho salmon, and if so, to what extent? Habitat in the project would benefit Coho salmon by: a) extending the range and distribution of the species thereby increasing the Coho salmon's reproductive potential; b) increasing genetic diversity in the Coho stocks; c) reducing the species vulnerability to the impacts of degradation; and d) increasing the abundance of the Coho population." Historic estimates are significant for the upper basin compared to current native coho escapement. In 1911, 881 female coho were captured at the Klamathon Racks egg-taking facility about 8 km downstream from the current Iron Gate Dam site (Hamilton et al. 2005). The current available coho habitat above Iron Gate is near historic conditions (e.g. Fall Creek, Spencer	This comment is noted. The report has been revised for clarification in response to this comment. The revised report provides a clearer statement of the potential benefits of increased habitat accessibility to coho salmon.

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			Creek, and Shovel Creek). The ODFW reintroduction plan will manage coho for wild fish only (ODFW 2008).	
155	W. Tinniswood	ii, 2 Under (2)	The fish passage conditions in Klamath Lake are not dissimilar to other areas of high summer water temperatures (e.g. Rogue River). Migration will cease typically in July through mid to late September. Summer steelhead are not expected to be migrating at this time or able to reach Upper Klamath Lake at RM 254. The fish passage conditions in Keno Reservoir under current conditions will likely have conditions conducive to passage in October when summer steelhead adults are first expected to be observed near Keno Dam (Huntington and Dunsmoor 2006). O. mykiss migrate through Upper Klamath Lake twice a year. Once in the summer to find thermal refuge then redistribute and can be found at the outlet of Upper Klamath Lake in October. The second migration is to the spawning tributaries and back into Upper Klamath Lake after spawning. O. mykiss of Upper Klamath Lake have been found to spawn up to six times (Borgerson 1992) The Link River ladder is a state of the art fish ladder that was constructed in 2003 for passage of suckers that typically do not jump to pass obstacles. The Keno fish ladder has had problems with attraction flow in the past but those problems appear to be rectified and the ladder is designed to pass salmonids. Steelhead migrate 1000's of miles in the Ocean therefore a migration of approximately 17 miles in Upper Klamath Lake is insignificant (Behnke 2002).	This comment is noted.
156	W. Tinniswood	IV, under water quality dam out	"Reduction in *Microcystis* is uncertain." ODFW believes this statement needs to be reevaluated. *Microcystis* only flourishes in lentic type environments therefore at the very least you would expect a reduction in a moderate gradient river reach.	Upon further consideration, the report has been revised for clarification in response to this comment.

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157	W. Tinniswood	17,1	The project reach will have the greatest production for coho and steelhead. Therefore dam removal is the best option for providing habitat for steelhead and coho salmon. Dam removal and benefits are a certainty (e.g. spawning habitat, rearing habitat, thermal refuge, improved water quality, and improved food resources.) The Klamath River also has the most productivity and food with the exception of Upper Klamath Lake. Above Upper Klamath Lake adfluvial *O. mykiss* will dominate leaving the small streams as the niche for steelhead (Everest 1973). Adfluvial *O. mykiss* have a higher survival and repeat spawning rate than steelhead giving them a size and fecundity advantage without the cost of migrating to the Ocean.	This comment is noted. The Panel modified the report to clarify between the difficulties in quantifying the benefits of dams-out with KBRA versus comparing dams-in versus dams-out with KBRA. The Panel cannot determine whether dams-out with KBRA is the "best option" because the Panel's charge was only to compare the two options. Determining optimal requires an evaluation of the many possible options.
158	W. Tinniswood	17, 4 (under 2)	ODFW does not believe trap and haul will be necessary for steelhead at Keno or Link River Dams due to migration timing. Trap and haul will not occur for coho salmon or steelhead (ODFW 2008).	This comment is noted. The report has been revised for clarification in response to this comment.
159	W. Tinniswood	17, 5 (under 3)	ODFW concurs with the expert panel on the possible impacts of hatchery steelhead. However, survival of hatchery steelhead appears to be low. Due to the abundance of *O. mykiss* below Keno Dam and in Spencer Creek ODFW believes that most steelhead will be produced from these areas immediately after dam removal. No hatchery steelhead will be stocked in Oregon. ODFW would recommend that all steelhead produced from Iron Gate hatchery are marked therefore monitoring facilities could exclude hatchery steelhead from Oregon or into spawning tributaries.	This comment is noted. Any additional information should be considered by the decision-makers in order to reduce uncertainties as much as possible. This information does not change the conclusions of the Panel at this time.
160	W.	17, (under 6)	ODFW recommends using information from the Rogue River as a	This comment is noted. Any

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	Tinniswood		surrogate for life history, abundance and movement patterns for coho and steelhead. A large data set exists for Huntley Park seine population estimates and migration timing and abundance at Gold Ray Dam. Rogue River is in the same ESU (Klamath Mountain Province). A good life history summary of steelhead occurs in Everest 1973.	additional information should be considered by the decision-makers in order to reduce uncertainty as much as possible. This information does not change the conclusions of the Panel at this time.
161	W. Tinniswood	24, 5	Summer Steelhead migration might be affected by dam removal in the winter and spring of 2020. Most of the sediment affects should be ameliorated during the upstream adult migration of fall and winter steelhead (July-December) and coho (October-December). ODFW assumes dam removal will begin in January of 2020 not in November.	This comment is noted.
162	W. Tinniswood	24, last	There is potential for significant spawning habitat for both coho and steelhead at the current location of Copco Reservoir (Hardy et al. Powerpoint 1-11-2011), areas below the state line to well below Shovel Creek (RM 202-207)(Fortune et al. 1966). PacifiCorp (2004) documented concentration of *O. mykiss* at the confluence of Shovel Creek and suggested these fish might be spawning in the mainstem, two miles at the Frain Ranch (RM 214-216) and below and above Spencer Creek (RM 225-227). Spawning in the mainstem has been reduced significantly due to peaking operations. The benefit of spawning near big springs in the Klamath River provides a thermal benefit on growth, survival and egg viability to salmon and steelhead. Once fry emerge this area also provides an area of increased growth due to warmer water temperatures. *O. mykiss* currently spawn in the springs reach Pacificorp (2004). Denman (2006) in expert testimony to the ALJ hearing observed spawning of *O. mykiss* in the Frain ranch area (RM 214) before construction of JC Boyle Dam in 1958.	This comment is noted. This information would have benefitted the Panel during its deliberations. However, the information would not have changed the conclusions of the Panel.

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163	W. Tinniswood	24, last	Approximately 1000 cubic yards of spawning gravel per year from 2012-2020 will be placed in the Klamath River below JC Boyle dam as part of the interim condition of the KHSA. Spawning gravel is easy to add and sources of gravel are available if this amount is not enough to provide good spawning habitat.	This comment is noted.
164	W. Tinniswood	24, last	*O.mykiss* currently rear in the entire river from Keno Dam to Copco Dam excluding the reservoirs in the summer. *O. mykiss (steelhead)* will not need to seek thermal refuge in this reach and will likely not need to seek refuge to well below the large spring fed tributary Fall Creek just above Iron Gate Dam. *O. mykiss* were even found in the fish kill in 2003 in J.C. Reservoir despite water temperatures ranging from 26-30 degrees.	This comment is noted. The Panel states that this is good information for future evaluation of the dams-out with KBRA scenario.
165	W. Tinniswood	25, third	Buchanan et al. (1991) documented tagged *O. mykiss* in the Link River recaptured on the spawning grounds of the Williamson River.	This comment is noted.
166	W. Tinniswood	26, second	Maximum depth of Upper Klamath Lake is 61 feet.	The report has been revised in response to this comment.
167	W. Tinniswood	27, second	Spring water temperature at the source typically ranges from 6-12 ° C degrees in the Wood River system, 2-3° C degrees in the Sevenmile Watershed, 7- 12°C in the Williamson River watershed and 14-16 °C in the Sprague River watershed.	This comment is noted.
168	W. Tinniswood	27, second	The west side streams on the Cascades are gravel rich (e.g. two gravel quarries exist on the alluvial floodplain of Cherry and Threemile Creek). Gravel from Threemile Creek Gravel Pit is used for gravel augmentation projects. Approximately 2000 cubic yards of spawning gravel 3/8 to 2 inch round river rock have been added to Spring Creek (1080), Wood River (200), Crooked	This comment is noted. This is useful information for future evaluations of the dams-out with KBRA scenario.

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			Creek and Tecumseh Springs (300) Agency Creek (300), Williamson River and tributaries (200), Fort Creek (50) Ranch Creek (100). All these projects have experienced almost 100% utilization by adfluvial *O. mykiss*. The SF and NF Sprague River and tributaries are also gravel rich systems.	
169	W. Tinniswood	28 first	The lower reaches of NF and SF Sprague are degraded but the upper reaches have excellent habitat and tributaries support bull trout as well as the NF Sprague in very low numbers. The lower NF Sprague is in better condition than the channelized lower SF Sprague River.	This comment is noted.
170	W. Tinniswood	28 last	Fortune et al. (1966) underestimated spawning habitat for steelhead. Fortune et al (1966) performed his assessment after the 1964 flood and on the Klamath River that had significant impacts from the hydroelectric system. During the time little information was available on the use of habitat by steelhead, the size of steelhead adults and life history. Fortune (1966) only documented very large habitat stream segments 46 years ago. For example an average summer steelhead is 18 inches and can use much smaller habitat than Fortune estimated. For example Fortune estimated that Spencer Creek could only support 110 pair of steelhead. However egg take from 1948-1956 from *O. mykiss* averaged up to 17 inches with usually over 1200 females collected each year. Recent escapement estimates into Spencer Creek by *O. mykiss* have been a minimum of 1800 (Buchanan et al. 1991) Fortune et al. (1966) also did not document any spawning gravel in Spring Creek (Williamson River). Spring Creek is now used by at least 1000 female adfluvial *O. mykiss* spawners that are significantly larger (22”) (Buchanan et al. 1991) than a 1 salt summer steelhead (18”) Everest 1973. Many other areas of good habitat were not considered by Fortune that have had recent gravel placement with good	The Panel doesn’t say whether Fortune et al. were right or wrong, but only the more modern assessments were more optimistic than Fortune and, as reported, were largely conducted through remote means. It would have been easy to conduct a defensible, systematic assessment based on direct field observations, rather than ad hoc observation and opinion about the totality. Clearly, a survey to document habitat usage is needed. Also, many statements are made about temperature being improved by KBRA activities, but again the degree to which that is known is never estimated. For example, one reviewer tells us that sedges, rather than taller woody plants will colonize stream banks. What is the

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			success. Everest (1973) found that almost all spawning habitat in the Rogue River by summer steelhead occurred in areas of intermittent streams of small watersheds. Despite Fortune stating that steelhead use intermittent streams for spawning with conversations with Coots Fortune et al (1966) did not estimate any of these stream types in his report. Fortune et al (1966) excluded the productive Fort Creek and tributaries, Crooked Creek and tributaries, Cherry Creek, Trout Creek, all tributaries to Sevenmile Creek and many other tributaries.	effectiveness of low-growing sedges in shading streams?
171	W. Tinniswood	29, 2	Most of the Williamson River and Wood River are in typically good condition as well as large sections of the Sprague River (38 out of 85 miles). The Sevenmile Creek watershed is experiencing significant restoration activities and the trend in habitat conditions are upward. Most of the Sevenmile Creek watershed is fairly pristine with the only impacts coming from roads. Habitat in the upper basin produces the most abundant and largest adfluvial *O. mykiss* known in the species range. The 136 miles of thermal refuge predicted by ODFW has good habitat to support all life stages of steelhead, and winter and summer thermal refuge if needed. The panel description of habitat describes sections of the Sprague River for approximately 40 miles, The South Fork Sprague for 8 miles, all of Whiskey Creek, most of Fishhole Creek, and small sections (3-4 miles) of the NF Sprague River, Sevenmile Creek, Wood River.	This comment is noted.
172	W. Tinniswood	34, 4	Bisson et al. (2003) determined juvenile salmonid abundance had exceeded the pre eruption abundance of Mt. St. Helens within three years. Even more surprising was the growth rate and survival of coho in the MT St Helens streams doubled coho growth in old growth forest streams (Bjornn and Reiser 1991 in	This comment is noted.

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			Bisson et al. (2003) and this growth and survival occurred in a stream that reached 29.5°. Two other streams that had survival of trout and coho salmon exceeded 24° degrees. Rearing for *O. mykiss* will occur throughout the reach and gradient is not a limiting factor for steelhead in this reach.	
173	W. Tinniswood	34, 3	Carter and Smith (2008) and ODFW (2010) not in literature cited	The report has been revised in response to this comment.
174	W. Tinniswood	35, 6	The dam removal scenario allows for migration during times of diurnal temperature fluctuations in the summer and returns the historic temperature regime as documented by water temperatures taken below Copco Dam in 1926. ODFW recommends review of these water temperatures (Larry Dunsmoor Powerpoint Presentation 1-10-2011) because the historic water temperatures give more certainty to the Bartholow Model (2005).	The report text about *Microcystis* has been revised for clarification in response to this comment.
175	W. Tinniswood	38, 5	*Microcystis* does not occur at high levels in Keno Reservoir and *A. flos-aqua* dominates therefore the removal of the four dams will reduce the growth of *Microcystis* due to lack of preferred habitat for growth. The river will assimilate nutrients more effectively than the current reservoirs and the improved biological component in the river (e.g. macroinvertebrates) will reduce fine and coarse particulate organic matter. Macroinvertebrate abundances are highest immediately below Keno and JC Boyle dams ranging from 20,000 to 100,000 m^2 (FEIS 1990 and 2007).	The report text about *Microcystis* has been revised for clarification in response to this comment.
176	W. Tinniswood	45, 2	Steelhead will be migrating during a time when water quality conditions are suitable in October-June (Huntington and Dunsmoor 2006 in Suitability of Environmental Conditions within	The Panel based on the concern with water quality in Keno Reservoir in part on Figure 3 in Hamilton et al.

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			Upper Klamath Lake and the migratory corridor downstream for use by anadromous salmonids). At Gold ray Dam (RM 125.7) on the Rogue River 52.8 % of the summer steelhead have arrived by 1 October. Keno Dam is at RM 230. Steelhead will likely be spawning in Oregon in March- May in snow melt dominated systems. Steelhead are expected to express the same life history as spring spawning *O. mykiss* and overwinter in Upper Klamath Lake, Keno Reservoir or large pools below Keno Dam (ODFW 2006).	2010. Evidence of successful passage and use of these river segments during critical times of the year was something we were seeking, and proposed as a research direction.
177	W. Tinniswood	45, 4	A very low level of predation will occur on steelhead and coho in the Klamath Basin. Mortality from predation from fish will be much lower than the Columbia River which has smallmouth bass, walleye and northern pikeminnow. The Upper Klamath Basin does not have these fish species. Bird species will predate on salmonids at very low levels but arrival of many of the predatory birds in the basin occur later in the spring when migration of steelhead smolts has already begun. Predatory birds also have access to the more abundant and slower swimming speed of fish in Upper Klamath Lake. Upper Klamath Lake is dominated by minnow species and sculpins. The biomass of these species are likely in the billions of fish. Simon and Markle (1997) estimated fat head minnow abundance on shoreline sampling sites as 40/m2 in good years. Abundant species include non native fat head minnow, tui chub, blue chub, marbled sculpin, Klamath Lake sculpin, shortnose sucker larvae, and Lost River sucker larvae. Large populations of young of the year yellow perch can also be found in certain years but recruitment into the adult population is low. Brown trout could be a predator in the Upper Sprague River, NF Sprague and Wood River. The large size of Upper Klamath Lake reduces the likelihood of	The Panel responds that this evidence for low predation and competition is plausible, but is far from definitive. The Panel raised the issue of jnterspecific interactions and maintains that if any one or more of these assertions is incorrect, then predation or competition can be a problem. Local, expert opinion is of great value but is also still opinion. Thus, the idea of asking an expert Panel their opinions.

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			predation by the bird population. ODFW's power point presentation did consider competition with steelhead and gave the board several references to consider on the subject (Payne and Kramer 2005). However, ODFW assumes that current *O. mykiss* production will produce steelhead thus a positive production from tributaries that are not producing large adfluvial *O. mykiss*. Competition will not occur from whitefish and redside shiners which can have competitive advantages over steelhead and rainbow trout (Reeves et al. 2008 and Pearsons 2005). Whitefish are the dominant salmonid in many Columbia basin rivers including the Yakima, Deschutes and Crooked Rivers which are also known as having good trout fisheries.	
178	W. Tinniswood	47, 6	*O. mykiss* larger than one salt steelhead can migrate through Upper Klamath Lake and Keno Reservoir (Hemmingsen 1997 and ODFW 2006) suggesting their offspring that travel to the ocean can also migrate through the system. If downstream steelhead stray to the Upper basin then the current migration pattern of adfluvial *O. mykiss* suggest steelhead can pass through Keno Reservoir and Upper Klamath Lake (ODFW 2006 and Hemmingsen 1997). Trap and haul activities for steelhead or coho will not occur. Water quality remains good for steelhead smolt outmigration into June and occasionally into July at Upper Klamath Lake and Keno reservoir. ODFW has analyzed the trap and haul scenario for chinook salmon as part of the Klamath Hydroelectric relicensing. ODFW will reiterate that steelhead will not need trap and haul due to migration timing of smolts and adults and current	The report has been revised for clarification in response to this comment. Specifically, the text has been revised to acknowledge current ability of *O. mykiss* to navigate Upper Klamath Lake and Keno Reservoir, but the Panel is not convinced that the poor water quality in Upper Klamath Lake will not continue to present a problem. The statement about trap and haul is at odds with other statements the Panel has received.

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			resistance of *O.mykiss* to the water quality in the upper basin (Li et al 2007).	
179	W. Tinniswood	49,1	Current densities of *O. mykiss* in the Klamath River below the powerhouse in the peaking reach is well below carrying capacity, condition factor is poor during winter and fall, and *O. mykiss* are not getting enough food to exceed 16 inches due to peaking impacts in this reach (City of Klamath Falls 1986, 1989, ODFW 2003 and Addley 2005, ODFW 2006). However, *O. mykiss* in the Keno Reach below Keno Dam under a more stable flow regime have excellent condition factor and abundance. The potential for steelhead in this reach is excellent but current conditions are unfavorable due to the hydroelectric project.	The report has been revised for clarification in response to this comment. The Panel thanks the commenter for the clarification.
180	W. Tinniswood	50,1	Several side channels and backwaters occur in the reach of springs and just below the springs. See Hardy et al. 2010 for current information or Google Earth.	The report has been revised for clarification in response to this comment.
181	W. Tinniswood	50,3	The temperature regime in Spencer Creek, Fall Creek and Shovel Creek are within the requirements of coho survival. The restoration of Buck Lake at the headwaters will allow coho and steelhead access to 27 cfs of spring water that will benefit the species in the summer and winter. Restoration of Buck Lake is high priority for ODFW.	The report has been revised for clarification in response to this comment.
182	W. Tinniswood	50, all	Short term effects on dam removal could have impacts to adult winter steelhead and possibly coho if completed in November. Coho will have already spawned if removal begins in January 2020 and summer and fall steelhead will be spawning in tributaries. A portion of the winter run will be impacted. ODFW understands that dam removal will be unlikely to begin in November of 2019.	This comment is noted.

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183	W. Tinniswood	50, 6	Currently there is not a problem with fish passage through Upper Klamath Lake and Keno Reservoir for *O. mykiss*. *O. mykiss* use Upper Klamath Lake and Keno Reservoir during fall, winter and spring (ODFW 2006).	See response to comment 178.
184	W. Tinniswood	51, 1	The four hydroelectric dams are the biggest limiting factor for redband trout and steelhead. The KBRA has limited value for the area in the project reach. The current state of habitat is good to excellent in the tributaries (ODFW 2003, 2006). The river will provide excellent habitat once the impacts caused by the hydroelectric dams are removed. Two anthropogenic landslides have occurred in this area at the emergency spillway and just upstream when a rock hit the bypass canal and eroded much of river bank in the river along with the 8000 cubic yards of gravel added by interim conditions and gravel from dam removal will improve spawning habitat in the mainstem. The emergency spillway continue to add substrate when used.	This comment is noted.
185	W. Tinniswood	51, (1)	The maximum swimming speed of steelhead is the highest of salmonids in the Pacific Northwest.	This comment is noted. The report had stated that steelhead were good swimmers.
186	W. Tinniswood	51, last	Steelhead will not likely need thermal refuge in the project reach. Juvenile and adult *O. mykiss* reach larger size, grow faster, live longer, have significantly better condition factor and relative weight from Keno Dam to J. C. Boyle Reservoir in a much warmer thermal environment than the bypass reach (powerhouse to Dam) that is dominated by 50 degrees spring water (ODFW 2003). Addley et al. (2005) found food supply not water temperature was the limiting factor for survival and growth of *O. mykiss* in the Klamath River. Food supply is limited below the dam due to hydroelectric stressors.	The Panel thanks this commenter for the new information; Addley 2005 was not provided to the Panel. The report has been revised in response to this comment.

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187	W. Tinniswood	52, 2	Link River fish passage was a concern in the past (Hemmingsen 1997) but the new state of the art fish ladder which has gradient to pass suckers far exceeds the requirements for steelhead passage. Keno dam fish ladder will be evaluated and improved for anadromous fish passage.	The report has been revised in response to this comment. Text has been added to acknowledge efforts to improve fish passage.
188	W. Tinniswood	52, 3	Predation is predicted to be much lower than Rogue River, Columbia River and Umpqua watersheds. The aforementioned watersheds have the potential for higher piscivory by nonnative fish species and native fish species. The literally billions of small fish in Upper Klamath Lake make the likelihood of predation of large steelhead smolts rare by *O. mykiss* the only large piscivore. Steelhead smolts exceed the maximum size of most minnow and sculpin species in Upper Klamath Lake with the exception of tui and blue chub that have been documented up to 16 inches. Terns, western grebes, white pelicans, night herons, great blue herons and cormorants will have predation on steelhead smolts at very low levels. All these birds typically do not show up in the basin until mid April. Caspian terns are rare in the area of Upper Klamath Lake and River.	This comment is noted.
189	W. Tinniswood	54,2	Small, high quality, productive habitat can produce significant densities of fish (e.g. Spencer Creek, Shovel Creek, and Fall Creek)	This comment is noted.
191	W. Tinniswood	54, last	Access through Upper Klamath Lake is feasible. A large number of sucker larvae which are drifting in the currents end up at the outlet of the lake from spawning areas in the Williamson River and along the east side of Upper Klamath Lake. Steelhead have amazing ability to migrate using the various cues to migration including olfaction and magnetic field (magnetite). Harris (1991)	The report has been revised in response to this comment. Fish passage issues have been addressed in text of the report.

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			documented millions of fish entrained down the A-canal at the outlet of the Upper Klamath Lake before screening.	
192	W. Tinniswood	54, last	Trap and haul will not be conducted for steelhead or coho. Downstream passage for smolts is good until late June for steelhead smolts in most years and there are no plans to trap and haul any smolts when the dams are removed (ODFW 2008).	This comment is noted. The Panel is at the mercy of conflicting information on this topic from local experts. For example, reviewer Dunsmoor above writes "Indeed, a seasonal (late summer – fall as needed based on water quality conditions) trap and haul from below Keno Dam to somewhere above Link River Dam has always been the intent. Such a program was required in 2007 as a Mandatory Term and Condition of a new hydropower license, and the fish managers plan to implement that program adaptively. As water quality conditions improve we intend to eventually eliminate trap-and-haul."
193	W. Tinniswood	55, all	Food production in Upper Klamath Lake and Klamath River is abundant in both macroinvertebrate and zooplankton abundance. Midges, oligochaetes and hirudinea are especially abundant in Upper Klamath Lake (OSU 1968). Midges were considered a serious nuisance in the 1930's and can still be a nuisance today. 542 billion midge larvae were estimated in 1932 and in 1968 an OSU estimated 438 (ca. 600 tons) billion midge larvae were estimated (1968). The most dominant species collected by the Ekman dredge by biomass was oligochaetes	The Panel responds that this is interesting information, if largely anecdotal. The Addley reference was not provided to the Panel, nor is it available through an online literature search; thus the Panel has no way to evaluate it and cannot incorporate its findings into the Panel's conclusions. The Panel have

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			followed by leeches, midges, clams and snails (OSU 1968). The area near Pelican Bay and just upstream of the Williamson River had the highest biomass. Max numbers of oligochaetes was 52 g/m2, leeches 5.3 g/m2 and midges 2.35 g/m2, amphipods 0.36 g/m2. Very small *Caenis* mayflies are also abundant in Upper Klamath Lake. Daphnia are the most abundant zooplankton in the lake by biomass and number. In 1964 and 1965 average daphnia abundance in a 10 liter plankton trap ranged at three sites from 88-105 on the bottom and 183-296 on the surface. Copepods ranged from 71-184 on surface to 76-128 on top (OSU 1968). Diet of Upper Klamath Lake *O. mykiss* typically comprises minnows, sculpins, leeches, midges and water boatmen. Ehlinger (1992) determined *Daphnia pulicaria* (sometimes referred to as *schroedleri*) abundance peaked in the summer durng the *A. flos-aqua* bloom and highest densities exceeded 100 individuals L^{-1}, 6000 ug dry weight, and 95% of the zooplankton biomass. The Klamath and Link River sections are dominated by chironomids (midges), *Hydropsyche* (net spinning caddis flies) *Simulium* (black flies), *Gammarus(scuds) Argia* (Damselflies), Ephemerellidae (mayflies), *Baetis* species, crayfish and leeches (hirudinea). Below the Big Springs complex *Pteronarcys californica (salmonflies) and Calineuria californica (golden stoneflies)* become abundant. The salmonfly hatch in the river below the powerhouse to below Iron Gate is a significant hatch and one of the best in the United States even with peaking process. ODFW hypothesizes that this hatch and insect production will be more abundant with dam removal. Density of invertebrates can be found in the Ferc EIS in 1990 and 2007 from Link River to below Iron Gate Dam. Addley et al. (2005) performed a bioenergetic and	amended the text on the lack of thorough study of the feeding environment.

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			macroinvertebrate drift study on the Klamath River from Keno Dam to below the powerhouse. Food is likely not limiting in the Klamath River and Klamath Lake but food can be limiting in the tributaries. Very few studies have looked at macroinvertebrate abundance in the tributaries. Growth rate in the spring fed streams and Spencer Creek appear slow as most age one *O. mykiss* range from 60-90 mm therefore a life history type that can take advantage of the lake and river will have a much faster growth rate. However, the stable conditions with flow and temperature in the early life history favors survival in the spring fed systems. That might be one reason that 100% of the documented adfluvial *O. mykiss* spawning occurs near groundwater springs. Returning salmon to tributaries and spring fed systems will improve the productivity and food supply for coho and steelhead juveniles. Studies have shown that improved riparian habitat can improve both aquatic and terrestrial insects abundance. Improvement of these conditions are a priority of KBRA. An easy split of habitat types would be that coho prefer slow water pools especially productive backwaters and side channels that are abundant in Spencer Creek whereas steelhead like the faster riffles and runs.	
194	W. Tinniswood	55,3	Removal of dam will not increase disease incidence over the long term. The expert opinion and matter of fact during the ALJ hearing in 2006 was: USFWS/NMFS ISSUE 2(B): To what extent facilitating the movement of anadromous fish via prescribed fishways presents a risk of introducing pathogens to resident fish inhabiting the basin above Iron Gate? "Facilitating the movement of anadromous fish via prescribed fishways presents a relatively	The report has been revised in response to this comment. The commenter says that there is a low risk of dam removal causing the introduction of pathogens to spread; the Panel agrees that there is a low risk but not a zero risk. Text in report was modified to reflect this low, but not zero, risk, and that

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			low risk of introducing pathogens to resident fish above Iron Gate Dam. Many of the pathogens (such as C. Shasta, F. Columnaris, P. minibicornis, and Ich) present below Iron Gate Dam, are also present above the dam. The evidence is inconclusive as to whether IHN exists either above or below Iron Gate Dam. The evidence is also inconclusive as to whether R. salmoniranrum exists above Iron Gate Dam" Some other major findings: 1) "For the most part, the pathogens existing in the lower basin historically and currently exist in the upper basin of the Klamath River above Iron Gate Dam" 2) "The existence of virus *Infectious Hematopoietic Necrosis* (*IHN*) in the Klamath River system is exceedingly rare" 3) "Nevertheless, because of its low levels, *R. salmoniranrum* does not appear to pose a significant risk of disease in the salmonid population in the Klamath River system, and consequently the bacteria will not pose a significant threat to fish in the upper basin" 4) "Since a majority of the pathogens currently found in the lower basin also exist in the upper basin of the Klamath River system, a logical conclusion is that migration of anadromous fish would not be a significant factor contributing to disease on resident fish" 5) "To the extent that migrating anadromous fish carry a unique highly virulent pathogen, disease management protocols could be used as is customary"	biological consequences, if this low risk event occurs, are severe.
195	W. Tinniswood	56, 1	Spawned out Chinook salmon carcasses.	The report has been revised in response to this comment.

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196	W. Tinniswood	57, 1	The condition below Keno Dam are not amenable to the proliferation of polychaetes and spawning salmon. A more free flowing river downstream like experienced in the reach of river with reduced spore load would occur with dam removal. The Klamath River mainstem above Iron Gate Dam has very low infection rates even for highly susceptible hatchery *O. mykiss*. Coho salmon should show a low rate of infection in this reach due to preferred spawning in the tributaries and reduced exposure to actinospores in adults during migration.	The Panel agrees this is a likely set of outcomes, but that some additional work could be done to reduce the uncertainties.
197	W. Tinniswood	57, 3	Macroinvertebrate abundance will increase greatly with removal of the dams that will be more effective at removing CPOM and FPOM. Increased vegetation like experienced in the Klamath River below Keno Dam, especially areas of cattail, will sequester phosphorus and nutrients.	This comment is noted.
198	W. Tinniswood	57, 5	The only factual information that we have above Iron Gate dam on coho salmon and chinook salmon mortality from ceratomyxosis is chinook and coho salmon survived in Upper Klamath Lake and Williamson River during a time when water temperatures were ideal for infection of *C. shasta* ranging from 13-20.5° in the spring (Maule et al 2010).More research is needed on the very recent discovery of *C. shasta* genotypes before we can make any claims of mortality in the Upper Basin. The current high spore load in the Williamson River is due to highly susceptible non-native hatchery rainbow trout released each summer in Spring Creek. This hatchery program is being evaluated for the effects of spore load in the Williamson River by ODFW and OSU. Why were Kokanee salmon able to survive in Upper Klamath Lake for likely two years without getting infected especially when they die and are likely to release spores that continue the	This comment is noted.

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			life cycle?	
199	W. Tinniswood	57, last	Rivers and streams other than Williamson and Klamath River do not support the life cycle of *C. shasta* to an extant to cause ceratomyxosis. The lack of *C. shasta* in the tributaries is likely due to lack of polychaetes in the tributaries. Upper Klamath Lake and Agency Lake also support the life cycle. This is despite the large migration of adfluvial *O. mykiss* from the Williamson, Upper Klamath Lake, Agency Lake and Klamath River into tributaries. The Wood River does not contain the parasite *C. shasta* (Hemmingsen et al 1989). Steelhead will carry little to no spore load that will not be unlike what *O. mykiss* carry into the tributaries (Mckenna 2006). Steelhead are likely not to die in spawing tributatries and release spores as they are iteroparous. Adult *O. mykiss* in Upper Klamath Lake rarely had spores of *C. shasta* (Hurst 2009). Adult mortalities on spawning grounds were not found to carry spores of *C. shasta* (Hurst 2009). In streams where *O. mykiss* do not have resistance to *C. shasta* suggest isolation from steelhead and adfluvial *O. mykiss* for a long time period because these fish should still be expressing a migratory life history at least to Upper Klamath Lake. Genetics of Deming Creek and Paradise Creek in the Upper Sycan and SF Sprague basin were not similar to steelhead but population in Trout Creek which has been documented to have an intermediate resistance to *C. shasta* did have a some genetic relationship to *O. mykiss* in the Klamath River (Pearse 2010). The above streams are similar to the Upper Williamson above a barrier waterfalls in which that population has no resistance to C. shasta (Hemmingsen 1988 and 1989). In summary the headwater populations are likely out of the range of summer steelhead. Steelhead are not likely to carry a large spore load. No evidence exists that has documented	This comment is noted.

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			abundance of polychaetes in the tributaries and resulting ceratomyxosis. Steelhead do not experience large mortalities on the spawning grounds thus releasing spores. Juvenile *O. mykiss* in the Williamson River show a higher infection rate than adult *O.mykiss* in the Upper Klamath Lake suggesting more resistance as and adult. *O. mykiss* from Spencer Creek (tributary to the Klamath River RM 226) were challenged in the Klamath River at the "hot zone" of *C. shasta* below Iron Gate Dam. Survival of Spencer Creek *O. mykiss* was high (Barthlomew pers. comm.).	
200	W. Tinniswood	58, 4	The population size that is most important is wild spawners. If fitness improves overall population size should be expected to colonize new habitats and use vacant habitat.	This comment is noted.
201	W. Tinniswood	62, 4	Fish passage at Keno Dam can occur during times expected for migration of summer and fall steelhead. KBRA offers the Klamath Tribe an interim fishing site below Iron Gate Dam.	This comment is noted.
202	W. Tinniswood	64, 4	Populations will not be lost in the headwater streams as no evidence exists to show that any tributaries will have any significant mortality from *C. shasta*. Even tributaries with large chinook and steelhead runs show limited signs of the disease ceratomyxosis (e. g. Trinity River, Scott River, Shasta River etc).	The Panel is not clear what exactly this comment is referring to. The Panel did not suggest that the dams-out scenario will cause loss of headwater streams.
203	W. Tinniswood	65, 4	KBRA will improve water temperatures in the Sprague River watershed. The Williamson River has a good thermal regime. Other tributaries to Upper Klamath Lake have excellent water temperatures due to the large springs (e.g. Barkley Springs, Harriman Creek, Recreation Creek, Odessa Creek, Short Creek) The Sevenmile and Fourmile Creek systems will develop large refugia areas at their mouth due to breaching of the levees at	The Panel states that this is another example of how lack of details in KBRA hindered the Panel's deliberations. While the Panel respects the commenter and his local knowledge, the Panel was charged with performing an

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			Agency and Barnes Ranch and flooding of the large, wide channelized sections of these two systems as part of KBRA. This will open up another 85,000 acre feet of habitat for fish.	evaluation with a set of information provided to them. Often, the response to Panel's questions of the local experts that KBRA will take care of that or KBRA will do that. In this specific comment, the Panel recalls Dunsmoor saying that sedges and rushes will colonize many stream banks. How does the commenter go from that information to the "improvement in water temperatures?" One of the Panel's job was to probe and question statements such as those made in this comment for the scientific basis.
204	W. Tinniswood	64, 5	Coho might be the only salmonid and fish that needs the refuge area during the summer as *O. mykiss* and other fish are not nearly to their temperature maximum. The habitat in this reach does favor *O. mykiss.*	This comment is noted.

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205	J. Kann Ph.D. for the Klamath Basin Tribal Water Quality Work Group	P. iv, Table ES-1, row 2 Water Quality	Quote from panel: "*Achieving reductions in Microcystis blooms is highly uncertain.*" We respectfully disagree with this summary statement regarding the *Conditions Without Dams and with KBRA* effect on *Microcystis* blooms (and subsequent production of the potent hepatotoxin, microcystin). This is addressed in further detail below, but the existing empirical data for the Klamath River system, as well as the body of scientific literature on habitat requirements for blue-green algal blooms, clearly show that without Copco and Irongate reservoirs the current blooms and downstream export of toxin below Irongate dam will be highly reduced, if not completely eliminated. See below for further detail.	The Panel agrees with this commenter, and the report has been revised in response to this comment.
206	J. Kann Ph.D. for the Klamath Basin Tribal Water Quality Work Group	P. 37, last sentence	Quote from panel: "*Achieving reductions in Microcystis blooms is highly uncertain.*" Same quote as above; see responses above and below.	The Panel agrees with this commenter, and the report has been revised in response to this comment.
207	J. Kann Ph.D. for the Klamath Basin Tribal Water Quality Work Group	P. 38, 3rd paragraph, 2nd sentence	Quote from panel: "*Experiments with nutrient addition showed N limitation of growth for total phytoplankton and for the cyanobacterium M. aeruginosa from Iron Gate and Copco reservoirs during summer (Moisander et al. 2009)*. While this statement is correct, Moisander (2009) also showed limitation by phosphorus as well as frequent co-limitation such that "at times P addition alone enhanced toxin concentration and *Microcystis* cell abundance, and when added in combination with N, cell abundance increased further".	The Panel has discussed this with Moisander and with H. Paerl. The main issue is whether *M. aeruginosa* will bloom in Upper Klamath Lake. Nitrogen limitation is likely to be the principal restriction on blooms. Either way, the lack of current blooms upstream of Keno is unlikely to change.

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			Quote from panel: *This potentially toxic form was first reported in 2005 (Moisander et al. 2009).*" *Microcystis* was reported in Copco Reservoir as early as 2002 (Kann and Asarian 2006), and the first confirmation of toxin production was in 2004 (Jacoby and Kann 2007).	
208	J. Kann Ph.D. for the Klamath Basin Tribal Water Quality Work Group	P 38. 4th paragraph p. 39, 1st paragraph, 3rd sentence	Quote: "*Although the cyanobacteria, notably M. aeruginosa, are of particular concern for the health of fish, the degree of reduction in either P or N loading required to eliminate blooms of M. aeruginosa cannot be determined with the present state of knowledge. Blooms of this cyanobacterium occur worldwide, and although generally they are understood to result from over-enrichment of nutrients, control strategies have been slow in coming (Paerl 1988).* Quote: "*Experience from other locations where eutrophication is a major problem suggests that, at a minimum, drastic reductions in loading from the watershed must accompany local amelioration.*" Both of these quotes indicate a possible misunderstanding by the committee in that the primary cause of the reduction of toxic *Microcystis* blooms in a "without dam" scenario would be the removal of the type of lacustrine habit required for the massive blooms to develop, and not the nutrient reduction strategies outlined elsewhere. Numerous references clearly portray the habitat needs of *Microcystis* as requiring the warm calm and stable conditions found in lakes, reservoirs, or very slow moving rivers. This information combined with the lack of growth of *Microcystis* (or even *Aphanizomenon* for that matter) in the river directly above the reservoirs, substantial blooms within the reservoirs, and transport downstream, clearly show	The Panel agrees with this commenter, and the report has been revised in response to this comment.

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			that removal of the dams eliminates the major *Microcystis* habitat, and would lead to substantially decreased levels of downstream transport of *Microcystis* cells and microcystin toxin. Numerous reports, as well as those by PacifiCorp clearly show the trend of decreasing blue-green algae in the river below Upper Klamath Lake, with a huge resurgence in Copco and Irongate, and subsequent transport downstream (Kann 2006; Kann and Corum 2006, 2007, 2009, Kann and Asarian 2007; CH2MHill 2008.) To reiterate, although nutrients are necessary for bloom proliferation, such concentrations alone are not sufficient to cause the magnitude of blooms observed in Copco and Iron Gate reservoirs. As a consequence, despite similar nutrient loads, *Microcystis* is uncommon in the free-flowing river reach above Copco. General literature that deals with this issue includes Huisman et al. (2004), who showed that potentially toxic *Microcystis* dominate at low turbulent diffusivity (calm-stable conditions) when their flotation velocity exceeds the rate of turbulent mixing. Such conditions occur in lakes and reservoirs as velocity and turbulence are reduced. Other literature also clearly demonstrates the link between buoyant blue-green algae such as *Microcystis*, *Anabaena*, and *Aphanizomenon* and the maintenance of thermal stratification such as that achieved in lakes and reservoirs, but not free-flowing turbulent rivers (e.g., Metrovic et al. 2003; Metrovic et al 2011; Oliver and Ganf 2000). Moreover, to the extent that climate change may increase water temperatures and thus increase water column stability in reservoirs, the presence of the Klamath River reservoirs may cause even greater blooms and downstream transport of toxin.	

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			For example, Microcystis is known to be favored by warmer water temperatures (e.g., Joung et al. 2011), and Pearl and Huisman (2008) state that "warming of surface waters also strengthens the vertical stratification of lakes, reducing vertical mixing", and conclude that ..."high nutrient loading, rising temperatures, enhanced stratification, increased residence time, and salination all favor cyanobacterial dominance in many aquatic systems". It is important to note that even with potential increasing river temperatures, the type of stratification necessary for blooms of toxic Microcystis to develop would not occur in free-flowing turbulent river reaches such as that occurs in the majority of the Klamath River. Such literature on *Microcystis* growth requirements and the need for warm, stable lake-like conditions in order to dominate, combined with the past 5 years of empirical data showing little to no growth of planktonic blue-green algae in non-impounded Klamath River reaches, clearly demonstrate that in the absence of the dams the issue of toxic *Microcystis* would be diminished substantially. There is a clear indication that not only can microcystin toxin in the Klamath River system be an issue with respect to public health, but that bioaccumulation and biomagnification of toxin has been demonstrated in a variety of aquatic organisms, including Klamath River salmonids. For example, samples collected from the Klamath River in 2007 indicate microcystin bioaccumulation in freshwater mussels from the Klamath River below Iron Gate, in yellow perch from Iron Gate and Copco Reservoirs, and concentrations of microcystin in the organisms indicated that consumption of such organisms would exceed established public health advisory values (Kann 2008; OEHHA	

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			2008; Kann et al. 2010). Regarding the concentrations of microcystin toxins in tissues of Klamath Basin salmonids, data from 2007 indicate microcystin bioaccumulation in juvenile salmonids reared in Iron Gate hatchery (Kann 2008) and trace concentrations of microcystin were found in Klamath River steelhead livers in 2005 (Fetcho 2006). Preliminary results from salmonid tissue samples collected by the Karuk Tribe in 2010 also show that 3 of 7 Chinook livers collected near Happy Camp had detectable levels of microcystin RR (data attached). During the period the Chinook were collected, the 2010 longitudinal microcystin sampling showed very high microcystin levels coming directly from Irongate and then transported downstream to areas where Chinook were migrating upstream. Laboratory and field studies from elsewhere have also demonstrated the toxic effects of microcystin on salmonids (Anderson et al. 1993, Bury et al. 1997, Landsberg 2002) and other fish (Smith et al. 2008). Based on these studies, and the documented presence of microcystin in the Klamath River and in Klamath River salmonid organs, the potential clearly exists for sublethal (e.g., stress and disease) effects on salmonids from exposure to algal toxins. Such effects would be substantially reduced or eliminated with dam removal and return of the reservoir habitat areas to that of a free flowing river that would not support the *Microcystis* blooms. References Andersen RJ, Luu HA, Chen DZ, Holmes CF, Kent ML, Le Blanc M, Taylor FJR, and DE Williams. 1993. Chemical and biological	

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			evidence links microcystins to salmon netpen liver disease. Toxicon 31(10):1315-1323. Biggs, B.J.F. 2000. New Zealand Periphyton Guideline: Detection, Monitoring, and Managing Enrichment of Streams. Prepared for Ministry of Environment. NIWA, Christchurch. Accessed online 11/4/20008 at: <http://www.mfe.govt.nz/publications/water/nz-periphyton-guide-jun00.pdf> Bury NR, McGeer JC, Eddy FB, and Codd GA. 1997. Liver damage in brown trout, Salmo trutta L., and rainbow trout, Oncorhynchus mykiss (Walbaum), following administration of the cyanobacterial hepatotoxin microcystin-LR via the dorsal aorta. Journal of Fish Diseases 20(3):209-215. CH2M HILL. 2008. Technical Memorandum: Blue-Green Algae (Cyanobacteria) and Microcystin Monitoring Results in the Vicinity of the Klamath Hydroelectric Project: September 9-11, 2008. Prepared for: Cory Scott (PacifiCorp), Linda Prendergast (PacifiCorp), Prepared by: Ken Carlson (CH2M HILL) and Richard Raymond (E&S Environmental Chemistry) DATE: September 22, 2008. Fetcho, K. 2006. Klamath River Blue-Green Algae Bloom Report, Water Year 2005. Yurok Tribe Environmental Program, Klamath, CA. <http://www.yuroktribe.org/departments/ytep/documents/YurokBGAReport032106.pdf> Huisman, J. et al. 2004. Changes in turbulent mixing shift competition for light between phytoplankton species. Ecology 85(11): 2960-2970. Jacoby, J.M. and J. Kann. 2007. The occurrence and response to	

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			toxic cyanobacteria in the Pacific Northwest, North America. Lake and Reserv. Manage. 23:123-143. Kann J, Corum S, and Fetcho K. 2010. Microcystin Bioaccumulation in Klamath River Freshwater Mussel Tissue: 2009 Results. Prepared by Aquatic Ecosystem Sciences, LLC., the Karuk Tribe Natural Resources Department, and the Yurok Tribe Environmental Program:23 pp. + appendices. Accessed online 12/8/2010 at: <http://www.klamathwaterquality.com/documents/2009_Klamath_River_FreshwaterMussel_%20Microcystin_%20Bioaccumulation.pdf> Kann, J. 2006. *Microcystis aeruginosa* Occurrence in the Klamath River System of Southern Oregon and Northern California. Report for the Yurok Tribe Environmental Program and Fisheries Department, Klamath, CA by Aquatic Ecosystem Sciences, Ashland, OR. 26 p. Accessed online 11/5/2008 at: <http://www.klamathwaterquality.com/documents/KannFinalYurokMsaeTechMemo2-3-06.pdf> Kann, J. 2008. Technical Memorandum: Microcystin Bioaccumulation in Klamath River Fish and Mussel Tissue: Preliminary 2007 Results. Aquatic Ecosystem Sciences, Ashland, OR. 13 pp. + appendices. Accessed online 12/8/2010 at: <http://www.klamathwaterquality.com/documents/2009/Kann_2008_Mussell_Bioaccumlation_.pdf> Kann, J. and S. Corum. 2006. Summary of 2005 Toxic Microcystis aeruginosa Trends in Copco and Iron Gate Reservoirs on the Klamath River, CA. Prepared For: Karuk Tribe Department of Natural Resources, P.O. Box 282 Orleans,	

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			cyanobacterial odorous and bioactive metabolites: Impacts and management alternatives in aquaculture. Aquaculture 280(1-4):5-20.	
209	Jack Stanford	Overall document, and specifically to pg iv and 53 concerning lack of clear hypothesis for how dam removal might improve coho	I don't disagree much with any of the panel's conclusions. They did what they could with what they were apparently given to work with and given the very short time frame for their work. But, I do think they were overly cautious in their conclusions especially as regards dam removal and restoration of ecological functions. My point is simply that they do not refer much to the broad literature on river responses to dam removal or redesigned flow regimes to improve ecological functions. The overwhelming conclusions from that broad literature is that a return to a more natural or normative condition can be expected to improve river ecology, often substantially (see 2010 issue of Freshwater Biology, among other often cited papers, notably Stanford et al., 1996 and Poff et al., 1997). This broad conclusion has held up in many cases where regulated flows were changed to a normative condition and in several cases where dams were removed and natural flows and passage restored. I think this general conclusion applies broadly to the Klamath and specifically to coho and steelhead. Poff, N. L., J. D. Allan, M. B. Bain, J. R. Karr, K. L. Prestegaard, B. D. Richter, R. E. Sparks, and J. C. Stromberg. 1997. The natural flow regime: A paradigm for river conservation and restoration. BioScience 47:769–784. Stanford, J. A., J. V. Ward, W. J. Liss, C. A. Frissell, R. N. Williams, J. A. Lichatowich, and C. C. Coutant. 1996. A general protocol for restoration of regulated rivers. Regulated	The Panel is aware of the broad literature on the responses of "river responses to dam removal or redesigned flow regimes to improve ecological functions." However, the Panel was asked to assess the likely effects of dam removal and other restoration activities in this particular river - which has many features that distinguish it from conditions sampled (often uncritically) in the broad literature. For example, in the Klamath, flow regime will not be strongly affected by dam removal or restoration activities. The flow, temperature and nutrient characteristics will still be dominated by Upper Klamath Lake. There will be a very limited sediment supply to the Klamath in the decades after dams are removed. Access to tributaries upstream of the Lake is not assured for coho, and the likely condition of these tributaries after extensive restoration activities is characterized only vaguely and uncritically at this time.

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			Rivers: Research and Management 12:391–413.	Unsubstantiated optimism, of the kind stated by this reviewer, prevails throughout most of the documents provided to the panel on this topic.
210	Hamilton	General Comment:	The hard work of the Panel and contractor are appreciated. We understand that the panel faced a difficult challenge in processing an enormous amount of material in a very short time frame. While the contract with PBSJ clearly states on page 2 that "These panels will provide information on population response to alternatives and other key questions identified by the BST", we understand that the report cannot answer questions in quantitative terms without any basis. However, that should not be a rationale for a report that 1) overlooks the administrative record for Klamath River and Hydro relicensing (Administrative Law Judge 2006, Federal Energy Regulatory Commission 2007),[1] 2) fails to answer questions on any basis other than models, 3) loses the thread of original questions, and 4) strays from the tasks at hand. These are fundamental problems with the report. DOI and DOC have prescribed fishways for the Project. These prescriptions have been examined in court based testimony. Based on this testimony, an ALJ has ruled in support of the prescriptions based on the science presented. Given these findings parties have entered into settlements (hence KBRA and KHSA). The questions posed to the Panel are in the context of this	The Panel respectfully disagrees with most of this comment. (1) We used the information provided to us; (2) We answered as many questions as we could and did this without a model; (3) We restated some questions so that we could answer them with the information provided (clarification text has been added to the report); (4) We consider the Preamble (which has been relocated to the back of the report) and other text as important caveats to our answers and thus as an important component of our responses (i.e., we did not stray). The benefits of an independent Panel are to tap into the wide and extensive expertise and experience of "outside" scientists. If a group of experts on a panel such as ours recommends certain models, had difficulties with the originally stated questions, and stated important caveats, this is good information for

[1] Neither appear to have been considered or are in the Literature Cited section of the report.

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			settlement and a very critical management decision being made on a limited time line consistent with the Settlement timeline. In many cases, the Secretary's management decision will have to be made with a limited amount of data or information. The SD management process affords the opportunity of conducting very little further research. The intent was that the report will render management level opinions to inform the Secretary in regard to whether or not the two alternatives will advance salmonid fisheries. What is needed are opinions from experts on <u>whether or not the two alternatives will advance salmonid fisheries.</u> The panel was convened because it is acknowledged that models, quantitative tools, and, in some instances data, are lacking. These are not the only tools available, however. Logical reasoning and the consideration of how the results of dam removal studies on other rivers might or might not apply to the Klamath River should be discussed in the report and applied, if only in qualitative terms. If necessary, the report has the option of providing caveats with an opinion. If necessary "The panel should be encouraged to identify levels of risk or uncertainty about future predictions." (p. 4 of the contract). But avoidance of any opinion because there is 'not enough information' is contrary to the task at hand and does not advance the decision before the Secretary. In some places the report has restated questions in way that has lost the intent of the original question and lost sight of the need to focus on differences between the two alternatives. Well beyond the scope of the contract and objectives, the report has in many places ventured into the identification of research and hypothesis testing (as the report does on page iii and elsewhere).). These ventures are unnecessary and neglect the	future work and next steps. Furthermore, if a panel such as ours had difficulty in forming specific conclusions (i.e., answering the questions to the degree desired), then this could suggest that the information has not been adequately synthesized or analyzed. The Panel appreciates the need for answers and the tight schedule, and we tried to accommodate this. The Panel tried to answer all of the questions but it seems the commenter does not consider "not enough information to answer the question" as a satisfactory answer. The panel disagrees with this view of the commenter. The answer is that the uncertainty is too high to make an educated opinion; guessing is not appropriate for an expert panel. Having said this, the Panel does recognize that the distinction between the two alternatives was not clearly identified as the target in the report. The Panel has revised the report to reflect this distinction.

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			responsibility to focus on the questions.	
211	Rondorf	General Comment:	The summarized answers from the Panel are often vague, inconclusive, and fail to compare conditions for the two proposed alternatives. However, under the same sections the Panel engages in valuable deliberations described in the discussions. Often the topic sentences in key paragraphs of the discussion describe clear and concise conclusions that are not transferred to the summarized answers.. Perhaps the summarized answers reflect authorship by committee and the more conclusive statements are by individual specialists that prepared the discussions. The report would greatly benefit from a strong linkage between the discussion and the summarized answers.	This comment is noted. The report has been revised and the Panel hopes it is clearer.
212	Hetrick/ Shaw	General Comment:	In March 2012, the Secretary of the Interior will decide whether removal of PacifiCorp Project dams on the Klamath River (1) **will advance salmonid fisheries,,** and (2) is in the public interest. Please note that the stated goal of the water and fish programs provided in the KBRA are, over time, to restore the "*natural sustainability of fisheries and full participation in harvest opportunities, as well as the overall ecosystem health of the Klamath River Basin*".". This is not consistent with the purpose of the Secretarial Determination referred to by the Panel as being to '*help restore federally listed populations of native fish species'*.	The report has been revised in response to this comment. The Panel notes that "advancing fisheries", "natural sustainability", and "full participation" are even more difficult to answer than "help restore native fish species." The Panel attempted to answer portions of this more difficult question (albeit to an unsatisfactory level for the commenter), but not all of the components. For example, the Panel stated in the report that we were not confident that a natural, sustainable fishery for coho would be established. Some questions cannot be answered without certain tools or information.

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213	Shaw	General Comments:	The vast majority of coho and spring Chinook salmon and steelhead spawn in tributaries. Fall chinook primarily spawn in mainstems. As such, questions posed by the Panel regarding mainstem spawning habitats for coho and steelhead, both above and below IGD, should not heavily influence their perspective and conclusions. The presumption that temperatures will be higher with dams out needs to be readdressed. JCB springs at 250 cfs, Jenny, Fall, Spencer, Camp, etc will influence temperatures along zones of the river and will actually provide cooler water temperatures throughout the summer, with significant utilization by both steelhead and coho. Coho salmon young of the year enter the Klamath mainstem and rear. Most mention of coho needs only address mainstem spawning and the migration of juveniles and adults. Change to a natural flow regime, large areas of mainstem with cold water and access to cold water tributaries will facilitate survival above IG. Mention of reduced fall flow is in error. All accretions between Keno and Iron Gate will be experienced below the existing location of Iron Gate Dam. Currently, all accretions with the reservoir project reach, unless under uncontrolled spill, are captured by the reservoirs and mediated by Link Dam releases, thereby allowing steady-state flows from Iron Gate to occur by fluctuating release from Link to offset accretions. Therefore, we will see higher fall flows below Iron Gate Dam, above base, when hydrologic events occur. The Panel's conclusion that the system will experience an increase in steelhead abundance but marginal increase in coho	This comment is noted. Model results presented to the Panel suggested temperatures with dams out would be slightly higher before August and slightly lower after. This comment is noted. The Panel relied upon the modeling effort and data provided by Blair Greimann, Bureau of Reclamation, which showed that average flows below Iron Gate Dam would be somewhat lower during fall after dam removal. This comparison was made to BiOp flows, which are recognized to be uncertain. The Panel is not clear about this sub-comment. At present, all

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			abundance under dams out with KBRA is not supported. I recommend the panel Google Earth Spencer, Jenny, and Shovel creeks. There is abundant habitat for coho salmon in these systems, which run cool during the summer due to spring water inflow. Coho salmon will likely pioneer, stray, or be actively reintroduced to these subbasins where they will likely be successful. The panel states that passage over Keno and Link is a problem. Current technology has advanced greatly with regard to providing fish passage for most migratory species and life stages, especially for relatively small facilities like Keno and Link. I see no need for trap and haul program given required passage upgrades at these facilities, which the panel needs to look at. The panel states that temperature conditions in UKL and Keno will be a problem. However, both coho and steelhead have evolved and will continue to adapt to their environment.. Adults move during periods having cooler water temperatures and smolts outmigate during the winter and early spring when thermal conditions are favorable for migration. The panel suggests that only a small extension of habitat will exist in the project area. Conversely, upon removal, JCB springs and numerous tribs entering the project will allow for juvenile rearing, as presently observed for red band. There are excellent tributaries entering the project reach, the mainstem between reservoirs is exceptional, other than the 2 mile area below JCB power house (adds aeration), and the habitat beneath the reservoirs are very low gradient alluvial area, with high sinuosity and excellent rearing potential. I suggest the panel Google Earth that area and look at historical maps to appreciate habitat	accretions between Keno and Iron gate Dam must be taken in to account when flows at Iron Gate are fixed under the BiOp. Why would this change if dams are removed? There will be uncontrolled additions of storm runoff between Keno and Iron Gate Dam "when hydrologic events occur" during the fall, but there is nothing to stop Link Dam releases to be reduced to compensate for the storm runoff, and the statement gives no basis for believing that such short-term additions of runoff will have any effect on fish habitat at all. Instead, the Panel discussed the Bureau of Reclamation's projections, based on transparent assumptions and climate projections. This comment is noted. Limited existing data indicate productivity of natural coho in the Klamath Basin is exceptionally low and the population is barely sustaining itself, or is persisting in response to some level of hatchery strays. Survival at sea is a key issue. Survival of smolts migrating down river also appears to be a problem. These issues may

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			potential that exists beneath the reservoirs. The Panel's reported adverse effects of sediment on adult steelhead and half-pounders spawning will not occur.. Steelhead typically do not spawn in the mainstem and half-pounders do not spawn at all. These fish have adapted over millions of years to respond to high turbidity events. They will seek turbidity refuge from tributaries and margins, just as they do to avoid high temperatures. The panel states that habitat is limited in the project reach due to high gradient and large substrate. I disagree. The small 2 mile section (Caldera/Hells Corner) is high gradient, but the majority of this reach has exceptional value to salmonids. There is ample fall Chinook spawning habitat and quality rearing habitat for all the native species and life stages.. Again, I suggest they Google Earth that section of the river to provide a visual overview of habitat availability. The panel should be made aware that there are significant accretions between Keno and Iron Gate (~150 TAF) that will not be constrained and metered by Iron Gate. This will allow for natural fluctuations corresponding to hydrologic events that are critical to many dynamic processes.. The panel speculates that coho will not expand to upstream habitats to any measurable degree. Coho are one of the most opportunistic salmonid species, showing strong tendencies for both adult and juvenile life history strategies, to search out and occupy new habitats immediately upon access. The panel doesn't mention the dynamic alluvial processes that will once again occur with dam removal. The river will no longer experience flat line flows due to the 150TAF of accretions	limit the potential benefits that might be otherwise gained by good habitat in tributaries above Iron Gate Dam. The Panel did exactly what the reviewer suggested, and reported more or less the same conclusion - without labeling the habitat "excellent" or "exceptional", which is not reliable from Google Earth observations or the historical maps. However, the Panel did not find the tributaries to be "numerous". The Panel's description of the stated issue differs from the reviewer's only its specificity, which was "The short-term effects of the sediment release will be sediment concentrations in the range of 1,000 to more than 10,000 milligrams per liter (mg/L) which will be injurious to upstream migrants of both species, and especially to any adult steelhead or "half-pounders" that hold or spawn in the mainstem. However, these high sediment concentrations are expected to occur for periods of a few months in the first two years after the beginning of reservoir lowering and

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			between Keno and Iron Gate. The river will experience sediment transport, both bedload and turbulence. We will have a natural distribution of sediment, both longitudinally and horizontally. The river will once again have recruitment of food, both indirectly, as leaves and organic debris that feed the invertebrates, and directly, as drift. The panel's mention of a possible decline in the coho population is unfounded. Again, coho will search out and find new habitat upon access. The thermal conditions and habitat quality above Iron Gate is good. I would propose that the anticipated beneficial effects of lowering C.shasta disease rates and the boost in population diversity will greatly increase the overall production and resiliency of the Klamath population and the overall ESU.	sediment flushing. For a few years after that period, suspended sediment concentrations are expected to be higher than normal, but not injurious to fish, especially in high flow conditions. Sediment concentrations are not expected to exceed levels that have been observed in large natural floods in the basin, although the duration of turbidities high enough to be a nuisance to feeding fish will be greater than at present. " The Panel did explicitly mention the dynamism of alluvial processes that will be re-established after dam removal, and the even more dynamic alluvial processes that will persist for years to decades after removal. However, once the natural sediment regime is re-established, the Klamath will return to its sediment-starved condition, due mainly to the fact that sediment supply is limited by Upper Klamath Lake. It is simply not true that one can extrapolate generalized findings about alluviation from other rivers to this particular one. The Panel notes the opinions of the

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				commenter in his last sub-comment. Clearly, the Panel came to a somewhat different conclusion. This seems to indicate that, indeed, the Panel did provide answers, because the commenter determined that he disagreed with the Panel.
214	Hetrick	General Comment:	Removal of PacifiCorp Project reservoirs would allow important coolwater tributaries (e.g. Fall, Shovel, Spencer, and Jenny creeks) and cold water springs such as the 225 cfs that enter the mainstem Klamath River between J. C. Boyle Dam and the Powerhouse, to directly enter and flow unobstructed down the mainstem Klamath River. These cooler water inflows will create thermal diversity in the river in the form of intermittently-spaced patches of thermal refugia. Thermal diversity will benefit a variety of aquatic biota during warm summer months and warmer periods during adult fall and juvenile spring-summer fish migrations.	This comment is noted.
215	Hampton	General Comment:	The panel states: "*The benefits to coho salmon of Conditions without Dams and with KBRA are expected to be small, especially in the short-term (0-10 years after dam removal). This will result from small increases in habitat area usable by coho with dam removal, small changes in conditions in the mainstem, positive but unquantified changes in tributary habitats where most coho spawn and rear, and the potential risk for disease and low ocean survival to offset gains in production in the new habitat.*" This finding doesn't appear to be consistent with current biological expectations for the following reasons. Removal of dams will provide coho with access to another 38 miles of mainstem habitat, assuming that their distribution will expand	Current but limited data suggest the productivity (e.g., return per spawner) of natural coho is very low and the population is barely able to sustain itself. In fact, it may only be sustainable because some hatchery fish stray to the spawning areas. In order for the new habitats above Iron Gate Dam to have a major impact on coho abundance, the overall productivity of those populations would need to be much

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			upstream at least to Spencer Creek, and also includes numerous tributary streams. Several of these streams contain springs that provide cold water habitats capable of supporting coho salmon rearing throughout the year. These include Spencer, Miner, Shovel and Fall creeks. In addition, Big Springs contributes an additional 220cfs of cold water (50 to 55F) to the mainstem below JC Boyle that will also improve water temperature conditions. Examination of historical topographic maps of the area now inundated by Copco Reservoir reveal the presence of additional springs and an alluvial channel with several off-channel habitat features that would likely support rearing coho salmon. There is abundant cold water habitat in low gradient stream reaches upstream of UKL that may also support coho salmon and the panel appears to have neglected to consider these habitat areas in their deliberations. I assume that this is because of poor water quality concerns in the Keno reach. If true, these concerns may be unfounded given the migratory timing for both the adult and smolt life stages. I suggest the Panel reconsider the potential of upper basin habitats to support coho salmon. The panel also suggests that the potential risk of disease and low ocean survival may offset gains in production associated with new habitats. There are several inconsistencies in this line of reasoning. First, even if we assume that disease impacts were equal under each alternative, the question before the panel is the comparison between habitats under no project and those provided under KBRA/KHSA. Based on the findings of panel creation of new habitat would be irrelevant, concluding that density independent factors drive coho production. Second, disease effects to coho salmon are anticipated to improve under the dams out scenario for multiple reasons, particularly in the	greater than what exists below Iron Gate Dam. So, while the new habitat may expand the capacity of the basin for coho, a key issue is whether survival will improve for fish in those new habitats. The Panel did revise the report to clarify when our responses referred to the magnitude of benefits of dams-out with KBRA versus the relative benefits of dams-in versus dams-out. The report section on disease has been modified. However, the general conclusion of the Panel that there is great uncertainty associated with how dams-out with KBRA will affect disease remains in the report.

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			short term: 1. Release of sediments currently behind the dams to the river will certainly have a major short term impact on polychaete populations, 2. D50 particle sizes in the infectious zone will decrease with a coincident increase in the frequency of bed mobilizations at lower discharges that should create more inhospitable conditions for the polychaete, and 3. Real time management of flows on a daily basis should create additional flow variability at the micro-habitat level further reducing habitats preferred by the polychaete, and 4. Under the KBRA flows in the spring will be greater than have been experienced in the past and the change in strategy to fill UKL earlier in the year is anticipated to increase the frequency of spill events which should reduce polychaete numbers through scour. The structure of the invertebrate community is likely to change once the influence of the dams is removed and although the effects of this change to polychaete populations is uncertain, there is a potential that these changes would be detrimental to filter feeding inverts such as the polychaete. We have discovered that under current (stable flow) conditions the polychaetes are capable of leaving their protective tubes to browse among detritus materials, however increased flow variability in the future with KBRA should reduce the effectiveness of the behavior to the detriment of the polychaete. I encourage to Panel to take the time to review the ALJ testimony which I believe will answer many of the questions that this panel appears to have struggled, particularly given the	The Panel was provided with an enormous amount of information, and was instructed to use that information as the basis for its

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			limited time frame that was provided to you. The panel expresses great concern over the level of uncertainty that exists in regards to activities identified in the KBRA. As a result, the findings of the panel in regards to the benefits that might be achieved for coho salmon are extremely pessimistic and conservative. Given the uncertainties, the panel could just have easily chosen a more optimistic interpretation of the potential benefits that could be achieved under the two agreements. I wonder what the panels justification is for choosing one path over the other, given uncertainty, one path of reasoning would not necessarily have been more correct than the other. In light of the evidence and given the simplicity of the question before the Secretary, removal of the dams alone will most certainly advance the restoration of the fishery more so than if the status quo is maintained. I encourage the Panel to take a more optimistic view of the potential to implement KBRA restoration actions and the Fisheries Program in an effective manner. Many of the Panelist suggestions, although outside the scope of their primary purpose are appreciated and many of the suggestions have already been discussed among the stakeholders.	report. This comment is noted. As stated above, the pessimism may have partly been due to statements about absolute benefits of dams-out with KBRA, and the high uncertainty associated with quantifying these benefits. This has been clarified in the report.
216	Rondorf	Title:	Comments on coho/steelhead report: Recommend the title be revised to have Klamath River Basin in it so that the report can be located on the www. For example, NRC 2008, “Hydrology, Ecology, and Fishes of the Klamath River Basin”	This comment is noted. The Panel has elected to retain the title of the draft report.
217	Rondorf	p. i, Report organization:	The first 24 pages of the report contain a mixture of information, describing the panel, the review process, the nature of the report, background, questions, and a preamble. We find the 3.1 Preamble to be a mixture of information either presented out of sequence or beyond the scope of the Panels task as described in	The Panel considers the preamble to be well within the scope of its charge. It describes the caveats associated with the Panel’s answers. However, it has been moved to the

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			the contract with PBSJ and identified in the questions posed to the Panel. A more appropriate location for the text on Page 17, Para 2 "We identified six principal obstacles to drawing convincing conclusions about these alternatives" would be in a conclusions section at the end of the report. As currently organized, the report ends abruptly with comments on climate shifts on page 68. A discussion of the strengths and weaknesses of the conclusions would inform the reader to a greater extent after presentation of the answers in the body of the report. In other words, the shortcomings of the answers would be more easily understood by the reader after the answers are presented.	end of the report to provide greater emphasis to the answers to questions.
218	Hamilton	p. i, line 4	The criteria for the Secretary's decision are not correct. Pls note the correct criteria underlined below. Consider replacing the 1st two sentences with: For decades the long-standing conflict in the Klamath River basin over water and fish resources has persisted. In an effort to resolve these disputes, PacifiCorp and interested parties negotiated, wrote, and signed the Klamath Hydroelectric Settlement Agreement (KHSA) in 2010, calling for the potential removal of the four lower dams on the Klamath River main stem. The KHSA established a process known as the Secretarial Determination, which includes: 1) conducting new scientific studies and a re-evaluation of existing studies found in the FERC record and from other sources, and 2) evaluating the potential environmental and human effects of such an action pursuant to NEPA, CEQA, and other applicable laws. In March 2012, the Secretary of the Interior will decide whether removal of these dams on the Klamath River (1) will advance salmonid fisheries,, and (2) is in the public interest. In this report, we review anticipated effects to fish resources	The report has been revised in response to this comment. However, the Panel is unclear about what "advance salmonid fisheries" means, particularly in the context of a listed species.

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			under two management scenarios: 1) current conditions with dams in place and without the programs and actions in the Klamath Basin Restoration Agreement (KBRA), and 2) removal of the lower four dams plus programs and actions called for in the KBRA and KHSA. This information will aid the Secretary of the Interior in determining whether dam removal and implementation of KBRA will advance restoration of salmonid (salmon and trout) fisheries. Since the Secretary's decision is not based on whether implementation would "(2) would help restore federally listed populations of native fish species", the discussion '*Coho salmon in the Klamath River Basin are included in the Southern Oregon/Northern California Coast Evolutionary Significant Unit (SONCC ESU) and were federally listed as threatened under the Endangered Species Act on May 6, 1997 (62 FR 24588).* *Critical habitat was designated for coho salmon on May 5, 1999 (64 FR 24049). Steelhead in the Klamath River Basin are included in Klamath Mountains Province Evolutionary Significant Unit (KMP ESU). While steelhead are not as yet listed as threatened or endangered, the National Marine Fisheries Service remains concerned about the status of KMP ESU steelhead (West Coast Steelhead Biological Review Team 2001), thus the ESU is evaluated herein' may not be necessary.*	The Panel thinks the quoted text is relevant to any actions meant to improve or increase populations of salmon.
219	Hampton	p. i,1	The report incorrectly states: "*The Secretary of the Department of the Interior is required to decide if implementation of the Klamath Hydropower Settlement Agreement (KHSA) and Klamath Basin Restoration Agreement (KBRA) is: (1) in the public's best interest; and (2) would help restore federally listed populations of native fish species.*"	The report has been revised in response to this and other comments. See response to comment 218.

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			For the Secretarial Determination as it refers to the KHSA this should read …1) will advance restoration of the salmonid fisheries of the Klamath Basin; and 2) is in the public interest. The KBRA has similar goals and must be authorized by Congress. Those goals are listed under section 1.3 of the KBRA. It is unclear why the panel believed that the agreements were specific to listed species when many of the benefits will also be realized by spring and fall Chinook salmon and steelhead trout.	
220	Hamilton	p. i, Para 2, line 3	If 'program's' reference is to KBRA, insert: Compiling the KBRA program's.	The report has been revised in response to this comment.
221	Rondorf	p. i, Para 2: General Comment:	We thank the Panel for their efforts and answers in the "Scientific Assessment of Two Dam Removal Alternatives on Coho Salmon and Steelhead". The Panel characterized the materials as "an enormous amount of material, spread out in many documents" and we are familiar with the challenge that presents. Also we acknowledge that the constraint of "only 5 days" was a demanding timeline and appreciate the quality of the scientific assessment given these constraints and others.	This comment is noted.
222	Hampton	p. I, Para 3	The panel is correct in stating that a detailed restoration plans for KBRA activities is missing from the materials provided. Since development of a basin wide restoration plan is one the key elements (benefits) described under the Fisheries Program (Part III of the KBRA), as is development of monitoring and reintroduction plans. Although these plans have yet to be developed, there are several watershed restoration and recovery plans available throughout the basin. The value of the KBRA is that all of these could finally be coalesced into one document	This comment is noted. Such a document would greatly help the deliberations of any future panel.

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			that has priorities at a basin scale rather than local scale.	
223	Hamilton	p. ii, (1), line 2	'*The benefits to coho salmon of Conditions without Dams and with KBRA are expected to be small*' This overlooks the following. Dam removal would result in access to at least 69 miles of currently unused main-stem and tributary habitat. Access to the historical habitat of the Upper Klamath coho salmon population, part of the federally listed SONCC (Southern Oregon/Northern California Coast) coho ESU (Evolutionarily Significant Unit), was significantly reduced when Project dams blocked access (Williams et al. 2006)[section 3.1.1 p.13]. In general, one assumes greater risk of extinction when less habitat is available across an ESU. Access to less habitat constrains the abilities of populations within the ESU, and the ESU as a whole, to persist (McElhany et al. 2000) [look at p.143 BoxA16-ESU Viability Guidelines]. Dam removal would provide access to suitable coho tributary and main stem habitat above Iron Gate Dam, including important rearing habitat in the Project tributaries and main stem, and cold water refugia below J.C. Boyle Dam. This includes Spencer, Fall, Shovel, Scotch, and other tributaries (ALJ Decision at 35, FOF 7-9). Historically, coho salmon spawned in Fall Creek (ALJ Decision at 12, FOF 2A-6). In addition, there are approximately 28 miles of suitable spawning habitat for anadromous fish in the main stem provided gravel augmentation occurs in those areas (ALJ Decision at 33, FOF 6-10). Dam removal would also provide access to over 22 miles of habitat under the existing reservoirs (Cunanan 2009) [look at p.3 Tables 1 & 2]. Over time, access to habitat above Iron Gate Dam would benefit the coho salmon population by: a) extending the range and distribution of the species thereby increasing the coho salmon's	The Panel acknowledged all of the information summarized here, and concluded that the net effect, compared to the current extent of habitat in the Klamath basin, where coho are not very productive at present, is likely to be "small". This is not "zero", but it is "small." A "moderate" response is possible but would require many aspects of this complicated program to be effectively implemented. This is the closest we could come to providing a quantitative estimate requested by the economists. The commenter's estimate of the net effect is free of any estimate of magnitude or likelihood.

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			reproductive potential; b) increase genetic diversity in the coho stocks; c) reduce the species vulnerability to the impacts of degradation; and d) increase the abundance of the coho population (Administrative Law Judge 2006) (ALJ Decision at 36, FOF 7-16). Coho salmon below Iron Gate Dam would migrate above the dam if access was provided (Administrative Law Judge 2006) (ALJ Decision at 35, FOF 7-15).	
224	Hetrick	p. ii (1)	Recent studies have shown that the elevated incidence levels of infectious diseases are adversely affecting freshwater production of Chinook and coho salmon smolts in the Klamath River, but as mentioned by the Panel, the degree to which populations are affected is unknown. Disease-induced mortality of juvenile downstream migrant salmon may not necessarily have a significant population level affect during years of diminished ocean productivity, which may limit ocean carrying capacity for salmonids. During years of poor ocean productivity, density-dependent survival in the marine environment may limit abundance of salmon populations rather than freshwater production. Conversely, during years where ocean productivity is high and survival is not significantly influenced by density dependent mortality in the ocean, high mortality of juvenile salmon in the river and the resultant decrease in the abundance of smolts entering the ocean due to disease-induced mortality, directly affect ocean abundance of Klamath stocks. In turn, lower ocean abundance is likely to result in decreased harvest opportunity and potentially, decreased spawning escapement to the Klamath Basin.	This comment is noted.
225	Rondorf	p. ii, (3)	*"The Panel was provided with qualitative information and asked to respond to questions requiring quantitative answers."* The above statement describes the Panel's task or guidance to	The Panel exercised that latitude in the case of coho, for example, by estimating that the net effect on coho populations is likely to be

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			the task from a very narrow view. In the introduction to the General Questions guidance was provided and that guidance recognized the difficulty of the Panel's task and the expectations that quantitative findings may be difficult. For example: "Our expectations are that in lieu of quantitative estimates, ranked value of abundance or an expression of change such as "two fold increase" could be used. Also useful is the trajectory of population abundance over time, such as declining or increasing under each of the proposed alternatives." Therefore, the Panel has wide latitude in providing qualitative answers for the two proposed alternatives.	"small", and "moderate" if many aspects of this complicated program are properly and effectively implemented.
226	Hamilton	p. ii, (1), line 5	*'This will result from small increases in habitat area usable by coho with dam removal, small changes in conditions in the mainstem, positive but unquantified changes in tributary habitats where most coho spawn and rear, and the potential risk for disease and low ocean survival to offset gains in production in the new habitat.'* Potential low ocean survival will be the same under both alternatives. Changes in tributary habitats may be unquantified, but what would be the difference under the two alternatives? What is the potential risk for disease under the two alternatives for next 50 years? <u>This conclusion misses the point of comparing benefits under the two alternatives which is the task of the panels.</u>	The report has been revised in response to this and other comments. The Panel states that it is not true that the Panel avoided comparing the benefits under the two alternatives. The Panel concluded that the results of dam removal on coho would be "small" due to "small increases in usable habitat: and "small changes in conditions in the mainstream" (for reasons that were explained), "positive but unquantified changes in tributary habitats", "the potential risk of disease and low ocean survival to offset gains in production in the new habitat". One could disagree with those conclusions, but they explicitly compare the results of the changes relative to current

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				conditions. The Panel has modified the text to more clearly state when referring to absolute benefits of dams-out versus comparing dams-in versus dams-out.
227	Hamilton	p. ii, (1), line 7	"*Very low current population levels and low demographic replacement rates imply that large improvements are needed to put this population on the road to recovery. Improvements on the order of two to four times the current freshwater survival are likely needed to offset low marine survival.*" This conclusion misses the point of comparing benefits under the two alternatives, the task of the panels. Incidentally, dam removal and KBRA represent the largest improvements available to managers.	This comment is noted. Dams out and improved habitat quality have the potential to increase capacity and productivity of coho. However, given that productivity of coho is presently very low and the population is barely replacing itself (difficult to determine with limited data and influence of hatchery strays), productivity would need to be increased substantially over existing productivity in order to produce harvestable numbers of Klamath coho. The implication is that some major limiting factor be identified and eliminated. Perhaps this limiting factor involves the disease. There are some interesting data, but still some unknowns about the extent to which disease is limiting productivity of coho salmon. How much better is habitat quality in tributaries above Iron Gate Dam compared with those below? Information of this nature was not provided.

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228	Hamilton	p. ii, (2), line 8	'*This is based on steelhead being given access to substantial new habitat, steelhead being more tolerant than coho to warmer water temperatures, the fact that other similar species (resident redband/rainbow trout aka O. mykiss) are doing well in the upstream habitat, and that steelhead are currently at lower abundances than historical values but not yet rare*.' Steelhead are also more disease tolerance. Klamath steelhead trout are resistant to C. shasta (Administrative Law Judge 2006) [p. 22, 2B-18]. However, Scott Foott has recently noted one exception to this.	This comment is noted.
229	Hamilton	p. ii, (2), line 15	'*how reliant the current population is on hatchery fish,*' There Is very little reliance on hatchery steelhead. In many recent years, returns of adult steelhead to IGH have been insufficient to meet the 200,000 yearling release goals (Chesney 2000)[p. 1]. During the 1970's and 1980's returns to IGH ranged from 832 to 4411. From 2005 to 2009 the peak return was in 2006-2007 with 212 steelhead; 140 fish returned in 2008-2009 (California Department of Fish and Game 2010)[p. 4].	This comment is noted. The report includes a table showing that ~100,000 yearling smolts were released from Iron Gate Hatchery and 792,000 were released from Trinity.
230	Hetrick	p. iii	*Effects on juveniles will occur but restricted to those in the mainstem, which should be a small percentage of the number of the juveniles in the system.* This statement does not recognize the predicted benefits of habitat and flow restoration programs in Basins like the Scott and Shasta as proposed in Appendix C of the KBRA, for example. *Achieving reductions in Microcystis blooms is highly uncertain.* Microsystin blooms originating in Project reservoirs will be eliminated and these currently inundated reaches will convert from being production to assimilation zones. Urge the Panel to	The report has been revised in response to this and other comments. The section on *Microcystis* has been modified in the report.

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			pictures of Project Reservoirs showing relatively clear inflows above certain reservoirs flowing into the fluorescent green reservoirs themselves (Thomas Dunklin photos available on-line).	
231	Hamilton	p. iii, (3), line 3	*'(2) fish passage'* How does fish passage have a bearing here? Do you mean passage through Keno, UKL? Need to be clear.	Yes, through Keno Reservoir and Upper Klamath Lake. Keno has and will have very low DO. The report has been revised for clarification in response to this comment.
232	Hamilton	p. iii, (3), line 4	*'(6) lack of understanding about coho and steelhead abundances,'* Table 2 in Hamilton et al. (Hamilton et al. 2010) provides run size estimates for coho salmon populations in the Klamath Basin (Williams et al. 2008). Hardy et al. (Hardy et al. 2006) [p. 6] report that historical run sizes for steelhead trout in the Klamath River basin are estimated at "400,000 fish in 1960 (USFWS 1960 as cited by Leidy and Leidy 1984)(Leidy and Leidy 1984) [p. 10]; 250,000 in 1967 (Coots 1967 in Hardy et al. 2006); 241,000 in 1972 (Coots 1972 in Hardy et al. 2006); 135,000 in 1977 (Boydston 1977 in Hardy et al. 2006); and 103,000 in the early 1980's (Hopelain 1998)[p. 1]".	The Panel responds that the estimates presented in Table 2 do not provide the necessary <u>understanding</u>, particularly inasmuch as they are aggregated over years, and have huge ranges. The Panel asks what have run sizes been in recent years?
233	Hamilton	p. iii, (3), line 8	*"Expert opinion", even of an independent panel, should not be used as a substitute for scientific analysis."* Unfortunately, the SD timeline does not provide the time to do these analyses as we would in an ideal word. That is why the Panels have been convened: to render an opinion for the	The Panel does not see a fundamental misunderstanding about its mission, but rather about what a group of scientists could be expected to accomplish in a week given more than 2 GB of documents and an inchoate set of

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			Secretary. This comment on the mission of the Panel and scientific analysis is unnecessary and inconsistent with tasks at hand. It appears to represent a fundamental misunderstanding that we need to discuss with PBSJ.	presentations. The Panel did what was asked: we rendered an opinion. As scientists, it would have been irresponsible of us to render an opinion about, say, the likely quantitative change in coho when in our opinion the available information was insufficient to support a conclusion about that change. The shortfall in information could have been addressed to a greater extent than it was, and recommendations for addressing that shortfall occur throughout the report.
234	Hamilton	p. iii, (3), line 9	*'the Panel offers general recommendations, beyond responding to the questions in the charge, which would ensure the best scientific information is brought to bear on this important issue'* This is mission creep and beyond the scope of the questions asked of the panel.	The Panel is trying to help. The Panelists are not robots but scientists, who as a class are generally unable to avoid thinking about what investigations might be in order and how we might be able to help our colleagues with their difficult task.
235	Hamilton	p. iii, Table ES-1, sed mgmt	*"Effects on juveniles will occur but be restricted to those in the mainstem, which…"* Missing word	The Table has been removed from the final report.
236	Hamilton	p. iv, Table ES-1, water qual	*'Achieving reductions in Microcystis blooms is highly uncertain.'*	The Panel agrees with this comment. The report has been

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			Incorrect. Conditions under which BGA blooms of *Microcystis aeruginosa* and *Aphanizomenon flos-aquae* (AFA) thrive will very likely continue with dams in. Reasons for its great abundance in these reservoirs is believed to be associated with limited mixing of surface water (thereby allowing stratification), a good nutrient source, and abundant solar radiation, and warm water temperatures (Asarian et al. 2009; Kann and Corum 2009). Conditions under which *Microcystis aeruginosa* and AFA thrive will be greatly reduced without reservoirs. We recommend that the Panel consult with the WQ team if they need further background or additional information.	revised in response to this comment.
237	Hamilton	p. iv, Table ES-1, adult/juv migration	*Both positive (e.g., greater access to habitat) and negative effects (e.g., higher summertime temperatures) associated with the action prevent the Panel from determining the net effect.* Please refer to Dunsmoor and Huntington (Dunsmoor and Huntington 2006) for analysis of mainstem temperature differences under the two alternatives. For adult coho, consider the effects of cooler fall temperatures under the dams out alternative (Bartholow et al. 2005). Relatively few coho reside in the mainstem during summer months. However, fall pulse flows move coho from upstream tributaries to downstream overwintering habitat in tributaries, side channels, and off channel areas (L. Lestelle comments to Expert Panel, 12/13/10). Cooler fall flows would be expected to improve survival during this migration.	The report has been revised in response to this comment. The Panel has made some modifications to the text involving this issue.
238	Hamilton	p. v, Table ES-1, access to habitat	*'Population responses of coho salmon are expected to be marginal.'*	The report has been revised in response to this comment. The

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			See Comment #14 above.	Table has been removed from the final report. The text in the report has been augmented to include small and moderate responses; "marginal" has been removed.
239	Hamilton	p. v, Table ES-1, refugia	*"If steelhead, and less likely coho populations, expand upstream of Iron Gate Dam, groundwater dominated habitats might allow persistence in the face of habitat losses that are expected under climate change scenarios."* Why would coho expansion be less likely? Does the report mean to lesser degree (in terms of miles of habitat)? For coho, this would include access to significant thermal refugia in J. C. Boyle by pass reach. Is this considered?	The Table has been removed from the final report.
240	Shaw	p. v	Reduced fall flows? The river will experience all accretions below Keno, now actively managed within reservoirs and controlled by PC and BOR. These accretions will increase flow volume and variability. *"Population responses of coho salmon are expected to be marginal".* We urge the Panel to take a close look at Spencer, Jenny, Shovel creeks as well as spring inflow thermal refuges as to their contribution to potential habitats for coho salmon.	The Panel was briefed by Bureau of Reclamation personnel that the flow at Iron Gate Dam is, and will continue to be, controlled according to the BiOp. The modeling effort by the Bureau of Reclamation showed that fall flows would be lower on average at the Iron Gate Dam location with the dams out alternative.
241	Hamilton	p. vi, Table ES-1, ecosystem function	*'The information available on the details of the KBRA is insufficient to answer this question, but opportunities exist to improve the state of knowledge on this topic.'* Hetrick et al. (Hetrick et al. 2009) provides ample evidence of the	The report has been revised in response to this comment. The information suggested by the commenter was considered by the Panel. Table ES-1 has been removed

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			benefits to salmonids associated with restoration to a more normative hydrograph under KBRA flows. Is this considered here?	from the final report.
242	Hamilton	p. vi, Table ES-1, disease	*'Removal of dams can result in reductions and increases in disease incidence. The information available is insufficient to determine the net effects. Studies and pilot manipulations could reduce the large uncertainty surrounding this issue.'* There is considerable information on the benefits of the Dams-out/Action Alternative in terms of reducing disease impacts in the Klamath River for coho. Refer to Panel presentations from Josh Strange at coho/Chinook panels; Scott Foott at coho/Chinook panels; and Bartholomew at Chinook panels. Information is also provided in the Hamilton et al. (Synthesis) document (Hamilton et al. 2010), in particular Table 3 and associated citations. Further information is provided in the peer reviewed 'Compilation of Information Relating to Myxozoan Disease Effects to Inform the Klamath Basin Restoration Agreement' (Bartholomew and Foott 2010). Bartholomew and Foott (2010) p. 18-The inflow areas to eutrophic lakes and reservoirs provide optimal habitat characteristics in terms of food availability, flows and dissolved oxygen and are among the most stable macrohabitat types where the polychaete has been documented. Removal of the dams would eliminate these reservoir inflow zones and either eliminate or redistribute the large polychaete populations that occur there to suitable small-scale habitats downstream. However, sandsilt habitats at these smaller scales are more susceptible to disturbance and thus less stable.	The report has been revised in response to this comment. Table ES-1 has been removed from the final report. The Panel familiarized itself with all of the available information on this topic, including a substantial literature that was not provided in the 2+GB sent to the Panel before the meeting. The report discusses this in some detail, and concludes that there are aspects of the expected revitalization of the river by dam removal that have not been given enough critical thought or investigation. It is telling that Jerri Bartholomew (at the Chinook panel) was much less sanguine about the degree of certainty about polychaete responses to dam removal than Josh Strange, who seemed unwilling even to consider the possibility of uncertainty in his conclusions.

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			p.21 section 3.3, p. 35 section 5.3 (plus more) It does not appear that this information was considered.	
243	Hamilton	p. vii, Table ES-1, recreational fishery	*"Depends on the effectiveness of the KBRA, fate of the hatcheries, and specifics of harvest policies, which are insufficiently defined at this time."* When passage for salmon and steelhead was created around dam sites on the St. Joe River in Michigan and Indiana, a significant fishery developed, resulting in a doubling of angler hours (Brian Gunderman, Michigan Department of Natural Resources–Fisheries Division, pers. comm.; Taylor and Wesley 2009). A similar fishery developed when passage for salmon and steelhead was created around dam sites on the Grand River in Michigan, although creel data are not yet available (Taylor and Wesley 2009). On the Sandy River in Oregon, removal of Marmot Dam allowed expansion of an existing fishery for salmon and steelhead and created additional access for bank anglers (T. Alsbury, ODFW, pers. comm.). It is reasonable to assume that harvest of steelhead will be allowed above the current location of the dams on the Klamath and more diverse life histories would likely develop over time. Would more diverse life histories result in different run timing, thus temporally expanded harvest and greater harvest opportunities? Would greater returns expand harvest locations and prolong harvest? Evidence for this includes the recent increases in sockeye salmon returns to the Columbia River that resulted in the expansion of	The report has been revised in response to this and other comments. Table ES-1 has been removed from the final report. The Panel states that, of course, the answer to the question posed by the commenter is "maybe." That is because of how the question is posed. Phrases like "more diverse life histories" and "expand harvest locations" lack any degree of specificity. From the perspective of this Panel, and most panels, such questions and answers are too vague.

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			harvest by Tribal and recreational fishers in time and space (Smith 2010).	
244	Hamilton	p. vii, Table ES-1, climate change	*'Dam removal would allow anadromous fish access to thermal refugia between Keno and Iron Gate dams.'* This would include access to significant thermal refugia in J. C. Boyle bypass reach (USDI Bureau of Land Management 2003)[p. 14]; considered?	The report has been revised in response to this and other comments. Table ES-1 has been removed from the final report.
245	Hamilton	p. 1, line 12	(2) should be 'will advance salmonid fisheries'.	The report has been revised in response to this and other comments.
246	Hamilton	p. 1, Para 3	This para needs to be rewritten to reflect that quantitative analysis tools and data are not available for coho/steelhead, and effects of the two alternatives on populations need to be evaluated by the EP.	This comment is noted.
247	Hamilton	p. 8, Para 1	'*Over and above the value of the Panel's assessment as a limited prediction, this review can serve as a guide for systematic data collection to reduce uncertainty in the future.'* This is beyond the scope of contract.	See response to comment 233.
248	Rondorf	p. 13, Sec 2.3.1 General Questions: and Appendix B, Panel Review Questions:	Each of the ten General Questions submitted to the panel had a reference to harvestable populations of fish near the end of the question. When the Panel restated the General Questions with the introductory commentary removed the Panel also removed reference to harvestable fish populations in 4 of 10 questions. The response of the Panel about the likely effect of the two alternatives on the harvestable fish populations was further diluted in the body because of numerous uncertainties. This is	The report has been revised in response to this comment. Some clarifying text has been added by the Panel. The main point of restating the questions is to focus them more on the putative mechanisms by which salmonid populations might be affected

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			an important aspect of the questions because the two criteria for the Secretary's decision are: 1) will removal of these dams advance salmonid fisheries, and 2) is removal in the public interest?	differently by the two alternatives. It is the Panel's opinion that the constant repetition of the expected increase in harvest seemed beside the point (especially for coho).
249	Hamilton	p. 17, 1.	*'The present specification of mitigation and restoration in the KBRA is extremely vague; yet, it is likely to have a larger but less predictable influence on the fish than removing the dams.'* What is basis for the statement that influence would be larger than dam removal?	See response to comment 254.
250	Hamilton	p. 17, 2.	*'…migration through Keno Lake and Upper Klamath Lake, and colonization of upper basin habitats are unknown. There is a significant probability that seasonal trap-and-haul programs will be necessary to reap the benefits to anadromous-fish habitat restoration in Upper Klamath basin.'* The panel may not have a clear understanding of trap and haul associated with future management. The need for trap and haul would be seasonal (U.S. Department of the Interior 2007)[p. C-61]; (National Marine Fisheries Service 2006)[Table 4 p. A-40]. Seasonal movement of fish would be around Keno reservoir, but may include movement around UKL as well.	The Panel responds that the commenter's description of trap and haul fits the Panel's understanding.
251	Hamilton	p. 17, 3.	*'Hatchery introgression could affect the development of well-adapted life histories in the wild stocks under the new conditions created by the project.'* More so than with dams?	The report has been revised for clarification in response to this comment. The Panel responds that the point is that the current and continued use of production hatcheries could inhibit development of locally adapted traits and thereby slow or inhibit

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				recolonization of new habitats.
252	Shaw	p. 17, etc. e	The uncertainty of hatchery integration of well adapted wild stock does not make sense. Stocks in the Upper Klamath Basin do not exist anymore as they were extirpated in 1918 with the construction of Copco I. I suggested a very diverse mix of stocks be used to seed upstream, similar to historical CDFG practices, to take advantage of as many genetically diverse traits as possible and let natural selection play its roll.	The report has been revised for clarification in response to this comment. The Panel responds that the point is that the continued use of production hatcheries could inhibit development of locally adapted traits and thereby slow or inhibit recolonization of new habitats.
253	Hamilton	p. 17, 4.	*'4. Uncertainty about the potential to control mortality of coho due to parasites in the Klamath River mainstem.'* Refer to Panel presentations from Josh Strange at coho/Chinook panels; Scott Foott at coho/Chinook panels; and Bartholomew at Chinook panels. Information is also provided in the Hamilton et al. (synthesis) document (Hamilton et al. 2010), in particular Table 3 and associated citations. Further information is provided in the peer reviewed 'Compilation of Information Relating to Myxozoan Disease Effects to Inform the Klamath Basin Restoration Agreement' (Bartholomew and Foott 2010).	See response to comment 242.
254	Hampton	p. 17, #1	*"The present specification of mitigation and restoration in the KBRA is extremely vague; yet, it is likely to have a larger but less predictable influence on the fish than removing the dams."* Removal of the dams will undoubtedly have much greater effects on the availability of habitats for anadromous fish than any of the restoration actions identified under the KBRA. Certainly, many habitat improvements that can be attributed to	The report has been revised for clarification in response to this comment.

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			KBRA would be nullified by the presence of the dams. Many restoration programs across the PNW spend millions to mitigate or improve poor habitat conditions that have been caused or exacerbated by the presence of mainstem dams. Here, we have an opportunity to remove 4 dams which are the primary factor responsible for causing major alterations to those natural conditions that once supported abundant and diverse salmonid populations. KBRA actions will not be near as effective without the ability to recreate a more variable natural flow regime and water temperatures. As long the dams are in place there will never be an ability to provide these natural traits so important to achieve restoration of natural ecological functions.	
255	Shaw	p. 17	Trap and Haul? There is ample technology and a FERC requirement to construct and maintain effective passage facilities. Migration through UKL and Keno will occur during non adverse time periods. "*Hatchery introgression could affect the development of well-adapted life histories in the wild stocks under the new conditions created by the project* ". The uncertainty of hatchery integration of well adapted wild stock does not make sense. Those stocks do not exist anymore as they were extirpated in 1918 with the construction of Copco I. I suggested a very diverse mix of stocks be used to seed upstream, similar to historical CDFG practices, to take advantage of as many genetically diverse traits as possible and let natural selection play its roll. Details for reintroduction of stocks to the upper basin will be worked out in the Reintroduction Plan called for in the KBRA.	The Panel refers the commenter to comments by Dunsmoor and Hamilton above. The report has been revised in response to this and other comments. Exceptionally low oxygen in Keno Reservoir is likely to persist from July through January, as it does now, and this would inhibit or block migration during this long period. The point is that the continued use of production hatcheries could inhibit development of locally adapted traits and thereby slow or inhibit recolonization of new habitats.

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256	Hampton	p. 17, #2	*"Serious uncertainty about fish passage and colonization."* The panel should focus their analysis to a simple comparison of two alternatives, the current condition versus those conditions that would be present with the removal of the dams and implementation of actions as described in both the KBRA and KHSA. There is 100% certainty that passage of anadromous fish will not occur with the dams in place. Prior to the construction of the dams anadromous fish used habitats upstream, including areas upstream of UKL (Hamilton et.al. 2005, Bulter et.al. 2010) and although water quality and habitat has been degraded, actions anticipated under KBRA are expected to rectify many of these issues. In addition, adverse water quality conditions that are anticipate to affect passage are seasonal and generally occur at times when anadromous passage is not a critical concern. Therefore, all indications are that these two programs will advance restoration of salmonid fisheries. This is the primary question posed to the Panel. The agencies and parties to the agreements recognize that trap and haul facilities might be necessary to move migrating fish around Keno and UKL at certain times of the year when high water temperatures and low DO levels (late summer) would be inhospitable to fish. However, for most of the year, water quality conditions along with construction of new fish ladders, will allow migration through these sections to occur as did historically (Dunsmoor and Huntington, 2006). Given the life history timing for both coho and steelhead, poor water quality conditions in this reach are not anticipated to be a major concern. Effective monitoring will be crucial to ensure that this is addressed appropriately as well.	The report has been revised in response to this comment. The Panel responds that in a simple comparison of the two alternatives, uncertainty about fish passage and colonization affects the likely magnitude of improvement in salmon numbers. In the obvious hypothetical case of dam removal but other blockages (dams or water quality) in place, then removal of the dam does not help. This is not the situation here, but just removing dams does not automatically mean significant improvements will occur. Wording has been added that dam removal is necessary for usage of upstream habitat but that actual usage depends on effective passage by the fish and the conditions in the upstream habitat.
257	Hampton	p. 17, #3	*"Hatchery introgression could affect the development of well-adapted life histories in the wild stocks under the new conditions created by the project."*	The report has been revised in response to this comment. Another example of information to come in

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			Genetic introgression is a concern and a Hatchery Genetics and Management Plan (HGMP) is currently being developed to help address this issue. Under the KHSA, Pacifi-Corp is only responsible to maintain hatchery mitigation levels for a period of eight years following dam removal and this will likely be contingent on the availability of adequate water supplies and facilities. Any additional hatchery efforts would be managed as a conservation facility whose purpose would be to aid in reintroduction efforts should natural re-colonization of historic habitats fail. (see KHSA interim measures 5, 18, 19, and 20). In the context of the primary question for the Secretary (will the project advance restoration of the salmonid fisheries of the Klamath Basin), the Panel should consider what the potential adverse hatchery impacts to wild populations would be in the future with and without the agreements. Without the agreements current hatchery production will continue. With the agreements hatchery production will likely cease 8 years following dam removal unless a conservation based hatchery is deemed necessary. Certainly, production of hatchery fish under this scenario (conservation hatchery) will be greatly reduced and will incorporate principles of genetic fitness in the process.	the future ("HGMP is currently being developed"). This substantiates the text in the report that hatchery effects can be a concern.
258	Hampton	p. 17, #6	"*Uncertainty about the potential to control mortality of coho due to parasites in the Klamath River mainstem*" Once again the Panel should be reminded of the basic question that's before them, which is a comparison between the no action and action alternatives. If the Panel believes that a return to a more normal or natural condition will reduce disease then the answer becomes obvious. Under the KHSA and KBRA flow, water temperature and sediment transport rates will return to a	The Panel has made a direct comparison of how dam removal, in the long term, will affect flow regimes (not much), water temperatures (slightly, but perhaps to an important degree), and sediment regime (intensification of transport and storage changes, creating a small amount of extra complexity). So, is the Panel's

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			more normative state. Under current conditions these processes have been altered greatly creating a more unnatural stable condition below Iron Gate Dam. Under which condition is disease more likely to be reduced?	reference to uncertainty that we are not sure that alteration of the channel bed and flow conditions will be suffucuent and effective in reducing disease conditions. Furthermore, there can be unintended consequences of a change to the ecosystem related to disease.
259	Rondorf	p. 18, Report organization:	On Page 18, Para 2, in a,b,c, and the panel identifies process, experiments and studies, monitoring programs, and a scientific advisory structure as needed. This information is well beyond the services requested of the contractor PBSJ, the scope of the questions presented to the Panel, and the timeline for the Secretarial Decision of 2012. However, we understand the Panel is trying to convey a more holistic view of the challenges and improve the process. The NRC (2008) also had a chapter on "Applying Science to Management" (Chapter 6) with somewhat similar insights. Inasmuch as the proposed experiments, monitoring program and scientific advisory structure are valuable recommendations, but not directly within the scope of the scientific assessment we suggest the Panel include in a section such as an "afterword" or "epilogue" in a book or identify in a section titled "in the future or beyond 2012" and locate the section at the end of the report. Please note the NRC (2008) located "Applying Science to Management" just before "Conclusions and Recommendations" the last chapter in their report. Relocating the materials about science and management at the end of the Panel's report would enable the reader to understand the weaknesses of the information discussed under the Panel's answers to the questions and provide a stronger	The Panel is in good company if the Panel's report and insights overlapped with an NRC report. Perhaps this suggests that these recommendations and comments have merit. The report has been revised to include a section at the end of the report that attempts to achieve what the commenter suggests.

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			basis for recommendations for the future by the Panel.	
260	Shaw	p. 18, Para 2	On Page 18, Para 2, in a,b,c, and the panel identifies process, experiments and studies, monitoring programs, and a scientific advisory structure as needed. This information is well beyond the services requested of the contractor PBSJ, the scope of the questions presented to the Panel, and the timeline for the Secretarial Decision of 2012.	The Panel respectfully disagrees with the commenter. If the Panel determined uncertainties were too large to allow for clear answers, then the Panel should identify how these uncertainties can be reduced.
261	Hetrick	p. 18	The panel identifies the need for various process, studies, experiments, monitoring program and a scientific advisory board. While these recommendations are valid and well received, they fall far outside the contracted purpose of the expert panels and will not be completed or in place prior to the Secretarial Decision in 2012. With regard to the Panel's statements on the need for a planning process to guide monitoring and restoration actions proposed in the KBRA – we concur and this need is reflected in a commitment to develop monitoring and restoration plans as called for in the KBRA. A "straw dog " for a process and template for developing a combined monitoring, research, and restoration plan has been prepared by the Service, with input, guidance, and support provided by the KBRA Fish Managers group - and can be made available to the Panel. However, this goes beyond the scope of what was requested from the Panel.	See response to comment 233 and other responses. The Panel determined that this text was an integral part of the answers, as they form the caveats to the answers and explain the rationale for some of the uncertainties.
262	Hamilton	p. 18, para 1, lines 6 through end para 2d.	...'*a decision to proceed with the projects should be understood as a decision to pursue a hypothesis,...*' This is beyond the scope of contract.	This comment is noted.

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263	Hamilton	p. 18, para 3, line 3	*'A short-term expert panel cannot do a comprehensive synthesis in a short period of time and does not replace missing investigations that could have been completed during the previous several years when the project was under consideration.'* This opinion is beyond unnecessary; it is a critique that was not specified as part of the contract, it is not part of any questions or requests, and it is beyond the scope of the tasks to the panel.	See response to comment 233. The report has been revised in response to this comment.
264	Hamilton	p. 18, para 3, line 8	*'the most frequent response is that we did not have sufficient information to truly answer the questions. For some (not all) of the questions that we were unable to answer, the needed information could be obtained but was not available.'* Please be specific; if the draft report can identify needed information that could not be obtained we would do our best to make it available.	The report has been revised in response to this comment. However, the Panel points out that in many comments where the commenter did not agree with the statements of the panel, such information was often cited. It is a difficult task to put together sufficient information without overwhelming a short-term Panel.
265	Hamilton	p. 19, para 1, line 1	*'The proposed restoration program would benefit greatly by developing and communicating a clear overall conceptual model, which then could be fleshed out with explicit modeling and statistical testing against observations.'* Beyond the scope of the tasks to the panel.	See response to comment 233.
266	Rondorf	p. 19, Para 1, L 2 & L 18:	*"a clear conceptual model."* We agree with the value of a clear conceptual model but the recommendation would be better located in a section on the future or beyond 2012.	This comment is noted. The Panel does not expect such recommendations to be acted upon before 2012.

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267	Rondorf	p. 19, Para 1, L 8:	*(sustaining fish Populations)."* Should refer to advance salmonid fisheries	The report has been revised in response to this comment.
268	Hamilton	p. 19, para 1, line 16	*'The panel is heartened…* Beyond the scope of the tasks to the panel.	See response to comment 233.
269	Hamilton	p. 19, para 2-all	Beyond the scope of the tasks to the panel.	See response to comment 233.
270	Hampton	p. 19, Para 3	"*Critical material, such as some of the daily flow modeling and the description of estimation methods for the monthly flow modeling, was made available to the Panel in draft form and with some lingering questions about the methods and results, especially the daily flow data."* This was an unfortunate situation and the Panelists are entitled to an explanation. One of the more difficult and important parameters for several analyses required for the Secretarial Determination is the modeling of flows under each alternative. Operational models for the Klamath Project simulate delivery of water to various areas of the project and are for the most part developed at monthly or biweekly time steps depending on the time of year. As I expect the Panel understands, monthly or biweekly time-steps are woefully inadequate for use in biological analyses. In addition, the irrigation project is extremely complex and incorporates a fairly large geographic area which complicates modeling efforts. This is further complicated by flow and lake level requirements imposed through various biological opinions each of which further restricts management flexibility. One of the most important aspects or opportunities available under the KBRA is the potential to initiate a real time management (daily) of river flows once the dams are removed	The Panel understands the difficulty of modeling streamflows, and if the uncertainty had been admitted in the original reports, the Panel would support such an admission. The Panel states that it was not the Panel that delayed the evaluation of the report because Panel members realize that it is highly unlikely that detailed predictions of the kind presented to us will withstand future validation. There are simply too many unknowns, there are non-hydrologic, regulatory requirements to be met, and the traditional hydrologic modeling technique of calibration based only on coarse-grained concepts for flow processes produces only an approximate view of likely outcomes. Thus, the commenter and the Panel

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			(Hetrick et.al. 2009). It was the desire to include this level of detail into the hydrology simulations that created the most difficulties for the federal team and since we did not have a perfect foresight or time to complete this difficult endeavor, I feel that our attempts to accomplish this will not truly represent actual flow conditions that are anticipated under the KBRA once the dams are removed. New flow management models will need to be developed in the future to accomplish this goal. I urge the Panel to recognize that natural flow and resulting water temperature regimes can only be achieved under the project alternative.	are left to base a conclusion about the likely effectiveness of dam removal and KBRA on approximate plans such as: some progress towards naturalization of the hydrograph; "the (unspecified) potential to initiate a real time management (daily) of river flows; and unspecified augmentation of 30,000 (or 20,000) acre-feet of water somewhere in the Upper Klamath Lake tributaries. Faced with these uncertainties, the Panel was asked to make predictions of the occurrence/ magnitude of range and populations increases for species fish that are already facing significant stresses (disease, ocean mortality, and climate change). The commenter asks the Panel to "recognize that natural flow and resulting water temperature regimes can only be achieved under the project alternative." But the various hydrologic modeling results do not show the prospect of achieving "natural flow and resulting water temperature". The system is quite far from achieving a natural flow regime, and proposed improvements --- although *probably*

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				real – do not seem likely to restore the natural regime to any significant degree, given the intensity of withdrawals and wetland drainage in the basin. We have no way of estimating whether the likely degree of restoration is likely to be effective in improving the range and population of each species. In the face of such uncertainty, the Panel was not asked to indulge in unsupported optimism.
271	Hamilton	p. 20, para 1	*'Perhaps repeated Panel meetings, designed to occur periodically throughout the evaluation process, could ensure maximum use of the expert panels.'* Some important syntheses have already been provided – see Federal Energy Regulatory Commission 2007; Hetrick et al. 2009, Hamilton et al 2010a. if the panel needs additional for review, that should be stated.	This comment is noted.
272	Hamilton	p. 20, para 3-all	*"Centralized scientific…"* The response to the reviews and subsequent changes that were made for the Biological Synthesis document (Hamilton et al 2010a) has been provided to the Panel. We would be glad to provide this again if needed. Limitations on time and other resources do not permit this tracking for other peer reviewed documents. *'…some of the reviews…'*	The report has been revised in response to this comment.

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			Which? Please identify.	
273	Hamilton	p. 20, para 4, line 5	*'There is no coho population dynamics model under active consideration at present, though one was developed for this project and then removed from Panel consideration.'* Important steps in the review process for major reports prepared for the SD are: 1) submittal to the Technical Management Team (mostly federal agencies) for SD, 2) solicitation of review comments from Stakeholders in the SD, and 3) solicitation of at least two anonymous peer reviews through an independent contractor. Unfortunately, to the best of our knowledge, the coho model report did not have the timely benefit of any of the steps identified above.	This comment is noted.
274	Hamilton	p. 21, para 2, line 2	*'We did not see mention of useful water temperature data predating the four lower dams.'* Larry Dunsmoor presented some temperature data pre-dating dams for Chinook panel.	This comment is noted.
275	Hamilton	p. 23, para 2 and 3-all	Beyond the scope of the tasks to the panel.	See response to comment 233.
276	Hamilton	p. 24, para 7, line 1	*'Dam removal will allow a <u>small</u> extension of spawning'* What is meant by 'small'?	The Panel responds that it is clear from the various values claimed by several commentators that there is little consensus on just how much "habitat (unspecified" or "spawning habitat") exists in the project reach and its tributaries. The estimates (whether or not they represent total

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				habitat or just spawning habitat) vary by about 100%. Nevertheless, the increments constitute a small percentage of the main stem and tributary habitat that is already available to coho in the rest of the Klamath River basin downstream of Iron Gate. In this context "small" means significantly less than 10%.
277	Hamilton	p. 24, para 7, line 5	*'Klamath River between Keno Dam and Shasta River'* You must mean Iron Gate Dam. There is no gravel source for Keno unless augmented.	Once dams are removed there will be passage of sediment all the way downstream from immediately below Keno Dam where natural sediment supplies will begin to enter the project reach from the valley walls.
278	Hamilton	p. 24, para 7, line 7	*'However, high water temperatures in the river will mean that young fish will have to seek refuge in tributaries during the summer.'* This discussion overlooks an important analysis below IGD. Dunsmoor and Huntington (Dunsmoor and Huntington 2006) analyzed conditions for juvenile steelhead with dams vs conditions without dams using another water quality modeling framework (the Klamath River Water Quality Model (KRWQM) developed for the Klamath River from Link River Dam to the estuary (Watercourse Engineering Inc. 2003; PacifiCorp 2004b; PacifiCorp 2005a; PacifiCorp 2005b) and references therein). Assuming that juveniles will seek thermal refugia when daily	The report has been revised in response to this comment. The information from Dunsmoor and Huntington are now incorporated into the final report.

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			maximum temperatures exceed 22°C, they used the KRWQM outputs to compare among different dams in vs dams out configurations the 1) frequency (number of days) with which juveniles would require thermal refugia, and 2) average minimum daily river temperatures for periods when thermal refugia would be occupied. They concluded (pages 20-22) that removal of the lower four dams provides a net benefit to juvenile salmonid use of refugia, because of the combined effects of decreased need for refugia in many reaches with the tendency for cooler daily minima in reaches where dam removal increases the need for refugia (Dunsmoor and Huntington 2006).	
279	Hetrick	p. 24	Presently, summer rearing habitat below IG does not exist due to adverse temperatures. Upon removal, JCB springs and numerous tribs entering the project will allow for juvenile rearing, as presently observed for red band.	This comment is noted.
280	Shaw	p. 25	Steelhead do not spawn in the mainstem and will seek turbidity refuge from turbidity just as they seek thermal refuge.	The Panel received conflicting information about whether ANY steelhead spawn in the main stem. Thus we wrote "any adult "steelhead or "half-pounders" that hold or spawn in the mainstem." This does not conflict with the commentator's statement.
281	Hamilton	p. 25, para 3, line 3	*'<u>coho</u> and steelhead can access the tributaries through Upper Klamath Lake.'* Coho may not have migrated through UKL. Hamilton et al.	The report has been revised in response to this comment.

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			(Hamilton et al. 2005) concluded that coho distribution may not have occurred upstream of Spencer Creek. Butler et al. (Butler et al. 2010) did not find evidence of coho above UKL.	
282	Hamilton	p. 26, para 1, line 2	*'This herd management'* Wouldn't this be more robust if 'herd' were changed to 'land'?	The Panel responds, but isn't the management of "grazing, browsing, and trampling mainly by cattle" herd management?
283	Shaw	p. 27	From the Hetrick et al. report… *Over 676 km (420 miles) of interconnected river and stream channels currently exist upstream of IGD that would provide functional spawning and rearing habitats for anadromous fish species, including spring and fall Chinook and coho salmon, steelhead, and Pacific lamprey, following removal of PacifiCorp Project dams (Huntington 2006). In addition, an estimated range of 98-379 km (60-235 miles) of potential habitat exists in the Upper Basin that could be rehabilitated into a functional condition for use by anadromous fish species.* The Panel's inability to confirm this statement is well justified. The line in the report should have read as follows… *In addition, Huntington (2006) reported a range of 98-379 km (60-235 miles) of potential habitat exists in the Upper Basin that could be rehabilitated into a functional condition for use by anadromous fish species.* We appreciate the Panel pointing out this statement.	The report has been revised in response to this comment.
284	Hamilton	p. 28, para 2, lines 3-7	Huntington (Huntington 2006) is another cite for this estimate	The report has been revised in response to this comment.
285	Hamilton	P. 29, para 3	Augmentation of spawning gravel is a likely outcome of KBRA	The report has been revised in

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				response to this comment.
286	Hamilton	p. 29, para 3, line 12	*'apart from the lower reaches there is very little spawning gravel, pool habitat, in-stream wood, or'* Incorrect. See Tech Memo (Hamilton et al. 2010) on pool depths in Williamson River. Much, perhaps most, of the lower 10 miles of the Williamson up to Spring Creek comprised of run and pool habitat. The Wood River also has extensive spawning and pool habitat, as well as Large Woody Debris.	The report has been revised in response to this comment.
287	Hamilton	p. 30, para 2	Also, Frain Ranch is low gradient	The report has been revised in response to this comment.
288	Hetrick	p. 30	Extracted from Stutzer, G. M., J. Ogawa, N. J. Hetrick, and T. Shaw. 2006. . U. S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata Fisheries Technical Report Number TR2006-05, Arcata, California. "Mainstem rearing The migration behavior of fish observed in this study suggests that segments of the wild and hatchery coho salmon smolt populations we tagged may use the mainstem Klamath River for rearing in spring and early summer, prior to continuing their migration to the estuary. While the overall percentage of tagged individuals exhibiting category 1 rearing behavior was relatively low (11% of tagged wild and 4% of tagged hatchery fish), it is likely rearing in the mainstem Klamath River was greater than we report. Our criteria to determine rearing required a live fish to remain at a single location for at least 24 h, thereby omitting fish that may have reared while slowly moving downstream. Tagged fish that moved short distances downstream (less than	The report has been revised in response to this comment.

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			about 100 m) between detections were therefore excluded as individuals exhibiting rearing behavior. It is also possible that a significant proportion of fish identified as exhibiting category 2 rearing behavior (16% of tagged wild and 15% of tagged hatchery fish) were indeed live coho salmon smolts rather than being tagged smolts in the stomachs of a mobile predatory fish. While difficult to assess due to depth and turbidity, this was visually confirmed by divers for two category 2 individuals that were observed holding and feeding in specific locations over the course of repeated detections until their tags expired."	
289	Hamilton	p. 31, para 3, line 1	*'Dam removal will have no significant effect'* Do you mean 'no' or 'little, if any'?	The report has been revised in response to this comment. "No significant" effect means there can be an effect but it will not be large in magnitude. Text was changed in the final report to say "small effects."
290	Hamilton	p. 31, para 3, line 6	*'However, the Panel was informed during the preparation of its report that there are still some questions about the reliability of the flow modeling. Proposals for purchasing 30,000 acre-feet of water and releasing it to tributaries of Upper Klamath Lake also remain undefined.'* The hydrology has been finalized. The assumption is that 30,000 AF included. Please refer to findings in ftp.usbr.gov/tsc/mdelcau/Klamath/Reports/Hydrology_Sediment	The report has been revised in response to this comment.
291	Hamilton	p. 31, para 4, line 6	*'The changes in sedimentation will have both short-term and long-term consequences.'* Are these positive or negative for fish?	The Panel responds that the effects on fish are elaborated in the subsequent sections of the report (short term and long term).

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292	Hetrick	p. 31	*The KBRA is intended to result in some adjustments to the late summer flow regime by increasing flows slightly in July through September, and decreasing them in October-December* I strongly urge the Panel to review Section I of the Hetrick et al. 2009 report. The water program in the KBRA, from the perspective of anadromous fish populations, focused primarily on conserving water in the late fall and winter to provide higher spring flows for fry and juvenile rearing in the spring and early summer. This is in addition to water that may be made available due to limitations on the quantity of water diverted from Upper Klamath Lake and the Klamath River for use by the Klamath Irrigation Project. This limitation would result in the availability of water for irrigation being about 10 to 26 % less than current demand in the driest years, with water availability for irrigation increasing on a sliding scale with increasingly wet conditions. The current pattern of agricultural water deliveries being higher in dry years than in wet years would be reversed.	The report has been revised in response to this comment. The section in the final report has been expanded to acknowledge the differences between the predictions by Bureau of Reclamation and the plans developed by Hetrick et al. to address more specifically the intentions for KBRA to improve spring and early summer rearing habitat for juvenile salmon. However, the Panel has no means of clarifying the source or reliability of the differences between the two predictions.
293	Hamilton	p. 32, para 3, line 1	*'Assuming dam removal begins in November'* Current thinking is that draw down would begin 1/1/2020	The Panel responds that since the Panel has no means of tracking the evolution of current thinking, there is no point in developing judgments based on the particular timing. So, the Panel reported only what Stillwater used as a starting point. The Panel presumes that the specifics of timing will be worked out by the agencies based on their knowledge of the river and engineering constraints.
294	Hamilton	p. 33, para 2,	*(Zedonis PPT presentation 8/2/2010).*	The Panel could not find this

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		line 4	This is updated by Draft Report from WQ SubGroup (Stillwater Sciences 2010)	reference in either Stillwater 2010 reports. In any case, the Zedonis reference was to a 2010 presentation.
295	Hamilton	p. 33, para 3, line 6	*'so it is likely to take more than a decade for the bed fining caused by dam removal to be reversed.'* Please refer to findings in ftp.usbr.gov/tsc/mdelcau/Klamath/Reports/Hydrology_Sediment	The Panel has incorporated references to the Greimann work at various places in the text of the final report, but we did not find any results referring to the long-term storage of sand in the bed. The conclusion is an interpretation by the panel about the likelihood that sediment around the margins and inundated floodplains of the reservoirs will erode gradually over decades after the first rapid release.
296	Rondorf	p. 31, Sec 3.2.5: p. 31, Sec 3.2.6 p. 33, Sec 3.2.7	*"Hydrology and Geomorphology without Dams and with KBRA"* *"Short-term Effects of Sediment Release*" "*Long-term Effects of Sediment Release"* The three sections on Pages 31-33 do not have an explicit explanation of what the consequences will be for salmon. What will the most likely short-term and long-term response of coho and steelhead populations to these sediment releases. Referencing later sections of the report where a response is described may be adequate, but not ideal.	The Panel responds that the effects on fish are elaborated in the subsequent sections (short term and long term).
297	Hamilton	p. 34, para 2, line 4	*'Thus, on average, gravel trajectories will begin farther from Iron Gate Dam than the finer sediment.'*	The Panel responds that the preceding sentence of the report states, "Most of the

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			Please explain.	gravel in the reservoir deposits is likely to occur around the upstream and lateral margins of each deposit, and particularly at the mouths of tributaries, gullies and eroding alcoves." The finer sediment deposits are thickest closer to each dam.
298	Hamilton	p. 34, para 3, line 2	*'...opening of approximately 69 miles of channel in the Klamath mainstem...'* For steelhead, at 420 miles of habitat would be opened up.	The report has been revised in response to this comment. Reference has been inserted to the final report in the text on the habitat and potential habitat.
299	Hamilton	p. 35, para 1, line 1	*'The most likely sites for significant sediment storage will be the several tributary junctions and about 4 miles around the current site of Copco'* Frain Ranch reach is low gradient as well.	The report has been revised in response to this comment.
300	Hamilton	p. 35, para 2	*Restated Question: What are the likely changes in water temperature regimes under the two alternatives and their effects on rearing and spawning life history strategies?* Both S-3 and C-3 ask how the two alternatives will differ, not what the changes will be, and how these differences will affect coho and steelhead over next 50 years.	The Panel states that the responses answer the questions of how they will differ and their possible effects.
301	Shaw	p. 35	Some mention of JCB springs and numerous cold tributaries above IG would be appropriate.	The Panel responds that springs are discussed elsewhere in the report.

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302	Hamilton	p. 35, Sec 3.3 w/o dams and with KBRA line 2	*'with ambiguous results for affected life stages that span that divide.'* Dunsmoor and Huntington (2006) provide modeling analysis. This section ignores this key piece of work.	The report has been revised in response to this comment.
303	Rondorf	p. 35, Sec 3.3: p. 37, Para 1: p. 37, Para 3:	"*Summarized Answers"* *"Daily mean temperature will be slightly warmer before and slightly cooler after August, with ambiguous results for affected life stages that span that divide"* *"This seasonal shift in daily mean temperature, if it materializes, would be good for salmon using the mainstem after August, this will include the coho and winter steelhead spawning migrations.* *"This could be detrimental to the fish."* The summarized answer indicates the results are ambiguous for the Panel's review of temperature. However, in the discussion for temperature the Panel indicates the results could be "good for salmon" and "detrimental to the fish". Why not carry the findings that the results could be good at times for some life stages and detrimental at times for other life stages. These are specific positive and negative findings. Summarizing the findings as "ambiguous" masks the valuable deliberations of the Panel and glosses over detailed findings in the discussion. Many of the "Summarized Answers" suffer from the similar ambiguous answers when the discussions contain valuable and specific conclusions. Try reading the other discussions and determine if the ambiguity in summarized answers really reflects the main points in the discussions.	The report has been revised in response to this comment.

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304	Hamilton	p. 37, para 4, line 1	*'On the other hand, if the fish use cooler hours of the night for migrating in the mainstem from...'* Strange (2010) found that Chinook salmon adults are capable of enduring, at least for a limited time period, potentially lethal instantaneous temperatures while continuing to migrate. The tagged Chinook adults still had high rates of success in reaching spawning grounds. There was no correspondence between initiation of upriver migration of adult Chinook salmon and changes in discharge, precipitation or atmospheric pressure. However declining light intensity as measured by mean daily solar radiation did correspond to initiation of upriver migration. For this study, the upper thermal limits to adult Chinook salmon migration are substantially higher than previously reported in the literature- 23^{o}C vs 21^{o}C.	This comment is noted.
305	Hamilton	p. 37, para 5	*'In other words, evaluating the net benefit or harm to fish from the temperature effects...'* Again, this information is not available in the time frame available. The determination will have to base conclusions on existing information.	The Panel responds that conclusions were based on existing information and directs the commenter to the summarized answers in the final report.
306	Hamilton	p. 37, paragraph 5	This discussion overlooks an important analysis below IGD. Dunsmoor and Huntington (Dunsmoor and Huntington 2006) analyzed conditions for juvenile steelhead with dams vs conditions without dams using another water quality modeling framework (the Klamath River Water Quality Model (KRWQM) developed for the Klamath River from Link River Dam to the estuary (Watercourse Engineering Inc. 2003; PacifiCorp 2004b; PacifiCorp 2005a; PacifiCorp 2005b) and references therein).	The report has been revised in response to this comment.

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			Assuming that juveniles will seek thermal refugia when daily maximum temperatures exceed 22°C, they used the KRWQM outputs to compare among different dams in vs dams out configurations the 1) frequency (number of days) with which juveniles would require thermal refugia, and 2) average minimum daily river temperatures for periods when thermal refugia would be occupied. They concluded (pages 20-22) that removal of the lower four dams provides a net benefit to juvenile salmonid use of refugia, because of the combined effects of decreased need for refugia in many reaches with the tendency for cooler daily minima in reaches where dam removal increases the need for refugia (Dunsmoor and Huntington 2006).	
307	Hamilton	p. 37, Sec 3.4 w/o dams and with KBRA line 4	*'Achieving reductions in Microcystis blooms is highly uncertain'* Please revise this section based upon information from the WQ team. Where is discussion about below IGD?	The report has been revised in response to this comment.
308	Rondorf	p. 37, Sec 3.4:	*"Water Quality, Conditions without Dams and with KBRA"* *"Achieving reductions in Microcystis blooms is highly uncertain."* We recommend the Panel review this finding and consider qualifying the conclusion with locations where it is applicable. For example, with dams removed it is unlikely that the zone of influence of *Microsystis* blooms will, extend as far downstream as it currently does. The Panel does not mention the apparent damage to fish from Microsystis and the relatively short lived persistence in organisms. Please consider consulting with the Water Quality SubTeam.	The report has been revised in response to this comment.

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309	Hamilton	p. 39, para 1, line 8	*'Thus, it would be premature to conclude that any problems caused by these blooms, including low dissolved oxygen, will be substantially reduced by KBRA.'* What about TDML?	The report has been revised in response to this comment.
310	Hamilton	p. 39, Sec 3.5 Discussion, lines 10 & 13	*'Klamath within the Coast Range, the middle Klamath between the Coast Range and Keno Dam'* Should be Iron Gate Dam. *'...coho spawning in tributaries versus mainstem habitats...'* See Table in Synthesis Document (Hamilton et al. 2010a).	The report has been revised in response to this comment.
311	Rondorf	p. 39, Sec 3.5	*"Adult /Juenile Movement and Migration"* *"Conditions without Dams and with KBRA: Both positive (e.g., greater access to habitat) and…"* In the discussion the Panel concludes *"Therefore, potentially lower flows during the fall under the Conditions without Dams and with KBRA alternative may reduce the ability of coho to reach spawning areas in some tributaries, although field studies indicate flows within tributaries is more important to passage than mainstem flows (Sutton 2007)."* This sentence in the discussion appears to be a conclusion, but it is not in agreement with the sentence in the Summarized Answer cited above. Futhermore, on Page 40, Para 3 the Panel cites simulated water temperatures that were estimated to be approximately 2-8 C cooler after removal of the dams, but does not cite this as a benefit in the Summarized Answer. In short, the Summarized Answers for Section 3.5 appear to be too short and cryptic to	The report has been revised in response to this comment.

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			fairly reflect conclusive statements reached in the discussion for this section.	
312	Hamilton	p. 40, paras 2 and 4	Don't these two paragraphs both cover the same ground on temperatures?	The report has been revised in response to this comment. The Panel responds that no, paragraph 2 refers to current conditions, while paragraph 4 refers to dams out. The Panel has added a few words to the text to clarify.
313	Hamilton	p. 40, para 2, line 5	*'For example, in 2002, average daily water temperature near Iron Gate Dam was 20°C in early September when coho began to enter the river, falling to 15°C at the beginning of the peak migration period in late October, and to less than 10°C by the end of the peak migration period in mid-November'* Why is this discussion on temperatures associated with low flows? This seems out of place.	The report has been revised for clarification in response to this comment.
314	Hamilton	p. 42, para 2, line 16	*'reached stressful levels, which might occur earlier <u>than</u> with the Conditions with Dams alternative'* Pls Insert word	The report has been revised for clarification in response to this comment.
315	Hamilton	p. 42, para 2, line 18	*'...without Dams and with KBRA alternative, and allow earlier and potentially longer access to mainstem habitats. But the cooler water with the dams out may reduce growth potential of fish residing there during fall.'* Wouldn't it allow the earlier migration to over-wintering habitat? See Lestelle power point presentation.	The report has been revised for clarification in response to this comment.

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316	Hamilton	p. 42, para 3, line 10	*'Flows in the Klamath River are not expected to change markedly during the spring smolt outmigration period'* Incorrect: These are flushing flows similar to a more normative hydrograph. See Hetrick et al. (2009).	The report has been revised for clarification in response to this comment. The Panel responds that the Greimann PPT Presentation did not reflect this, but that a reference for Hetrick has been added to the final report.
317	Hamilton	p. 43, w/o dams and with KBRA, line 2	*'The area of <u>mainstem</u> spawning gravel'* Insert word	The report has been revised for clarification in response to this comment.
318	Hamilton	p. 43, w/o dams and with KBRA, line 4	*'Reduced fall flows in mainstem may hinder coho spawning migrations to tributaries.'* What is the basis for this conclusion?	The Panel responds that the Greimann PPT Presentation shows reduced fall flows. Others have reported coho access issues, although this is mostly due to low flow in tributaries, as stated.
319	Rondorf	p. 43, Para 2 and 3:	"*Conditions without Dams and with KBRA:……Reduced fall flows in mainstem may hinder coho spawning migrations to tributaries*" "Discussion: ……*Basin-wide quantitative estimates of spawning coho salmon in the mainstem versus tributary habitats are lacking in part because of fall and early winter storm events can make enumeration difficult.*" Although the above statements are both correct, they may seem contradictory to some readers. Fall and early winter storm events do make enumeration of redds and/or estimates of spawned adults more difficult. However, the storm events can also mitigate low fall flows and may be associated with	The report has been revised for clarification in response to this comment.

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			movements of adults onto spawning areas.	
320	Hamilton	p. 44, para 1-all	Discussion needs to include gravel effects below IGD.	The Panel responds that paragraph 2 does discuss spawning gravel below Iron Gate Dam.
321	Hamilton	p. 45, w/o dams and with KBRA, line 2	*'...through Keno Reservoir and Upper Klamath Lake is successful, then increased access to upstream habitat (above Upper Klamath Lake) could increase the abundance of steelhead (possibly substantially) if fish utilize the new habitat and can successfully complete their life cycle. Population responses of coho salmon are expected to be marginal.'* When needed, seasonal Trap and Haul of steelhead (around Keno and possibly UKL) is part of the Dams out + KBRA alternative.	The Panel received conflicting information about whether trap and haul will be used.
322	Rondorf	p. 45, Para 2:	*"Assuming that both upstream and downstream passage through Keno Reservoir and Upper Klamath Lake is successful, then increased access to upstream habitat could increase the abundance of steelhead (possibly substantially) if fish utilize the new habitat and can successfully complete their life cycle."* The stated assumption that upstream and downstream passage through the reservoir and lake should be qualified with recognition that trap-and-haul is an alternative. The Panel cites reintroduction programs on the Cowlitz and Toutle River, WA. Decades of experience on those two basins indicate collection of juvenile migrants may be more problematic in the near-term lacking collection facilities, but trap-and-haul of adults is likely to be a feasible management strategy.	The Panel received conflicting information about whether trap and haul will be used.
323	Hamilton	p. 46, para 1,	*'contribution of individuals'*	The report has been revised for clarification in response to this

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		line 1	It is inappropriate to use spawning and reproductive success for Iron Gate Hatchery here. These values are derived from studies of hatchery fish. Survival of wild fish would be different.	comment. A caveat has been added to the final report that survival of wild fish will likely be higher than hatchery fish.
324	Hamilton	p. 46, paragraphs 3 & 4	Also see Synthesis Document (Hamilton et al. 2010a) and Kiffney (Kiffney et al. 2008). Explain further evidence that colonization by coho would be less likely.	The Panel responds that the text seems clear.
325	Hamilton	p. 46, para 5, line 7	*'been historically present <u>up to</u> Spencer Creek'* Replace '<u>up to</u>' with '<u>at least to' (Hamilton et al. 2005).</u>	The report has been revised for clarification in response to this comment.
326	Hamilton	p. 46, para 6, line 4	*'described as "unused" but are in fact occupied'* Again, an example of discussion that is beyond the scope of the question. The questions to the panel are in the context of use by anadromous fish. This comment is unnecessary.	The Panel respectfully disagrees with this comment. Salmonids exist within a community; biotic effects, whether disease, predation, or competition, will influence responses of the species of interest to actions such as dams-out.
327	Hamilton	p. 47, 1., line 1	*'1. The extent of <u>competition and predation experienced by colonizing steelhead, particularily the partitioning of resources...</u>* *Again, an example of discussion that is beyond the scope of the question.*	The Panel respectfully disagrees with this comment. The question is how will increased access to habitat benefit coho and steelhead. Competition and predation are biological processes that affect the benefits to coho and steelhead of the new habitat.
328	Rondorf	p. 47, Para 2:	*"Success and productivity of steelhead and coho salmon in the*	The Panel received conflicting information, and continues to in the

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			newly accessible habitats will depend on the following factors: *2. Migratory survival of steelhead adults and juveniles through Upper Klamath Lake and through the Link Fam to Keno Dam reaches where poor water quality may create barriers to successful movement (ODFW 2010).”* Management to facilitate migration and improve survival of adults and juveniles through trap-and-haul is again minimized through omission.	comments, about the role of trap and haul.
329	Hamilton	p. 47, paras 3 & 4	Again, an example of discussion that is beyond the scope of the question.	See response to comment 233.
330	Hamilton	p. 48, para 3, line 8	*‘...much less important for coho salmon unless they too are...’* Coho were not likely historically distributed this far upstream Hamilton et al. 2005; Butler et al. 2010.	The report has been revised in response to this comment.
331	Hamilton	p. 49, para 3, line 9	*(Carter and Kirk 2008)* This is not in the Lit. Cited section.	The report has been revised in response to this comment.
332	Rondorf	p. 50, Para 2	*“(Chesney and Yokel 2003)”* Chesney et al. (2009) is in references but I do not find Chesney and Yokel (2003).	The report has been revised in response to this comment.
333	Hamilton	p. 50, para 1	If mentioning fall-run Chinook, this should also mention spring-run Chinook?	This comment is noted.
334	Hamilton	p. 50, para 2, line 6	*tributaries to the mainstem below IGD may be a ~~losing~~ minimally successful tactic for coho salmon* suggested word change	The report has been revised in response to this comment.

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335	Rondorf	p. 50, Para 4:	*"3.9 Habitat Restoration (S-7) Summarized Answers: Conditions with Dams and Conditions without Dams with KBRA:"* The response in the answers indicates *"effectiveness is unknown"* and *"effects on abundance are unknown".* The answers do not indicate the Panel made an attempt to compare the two proposed alternatives. Perhaps the Panel could make some relative or qualitative observations about the two alternatives, rather than just indicating there are unknowns for both alternatives. Furthermore, the panel is unresponsive to specifics in the question about productivity, capacity, or habitat connectivity. The first sentence in the Discussion is an example of a conclusion about the conditions without dams with KBRA. It reads: *"The Panel can only state that if the KBRA is implemented effectively, improved habitat conditions are likely for steelhead."* This topic sentence is more concise and definitive than most answers in the report.	The report has been revised in response to this comment.
336	Hamilton	p. 50, w/o dams and with KBRA, line 2	*'Passage through Keno Reservoir and Upper Klamath Lake could continue to be a problem.'* Water Quality improvements, including TDML would occur sooner under KBRA. Trap and Haul when needed for seasonal WQ is part of the Dams out + KBRA alternative (see appendix c2).	The report has been revised in response to this comment.
337	Hamilton	p. 51, Discussion	This entire discussion seems to be based on the discomfort the Panel has with nonspecific nature of KBRA management to the point that it ignores the dam removal part of the alternative. The habitat connectivity response to the question is missing.	The report has been revised in response to this comment. The Panel responds that the commenter is correct. If KBRA is critical to the program, which the Panel was told it was, than it seems logical that lack of specifics about KBRA would make an expert panel charged with

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				offering their opinions quite uncomfortable. There is too much "trust me", and the Panel's experience with other large-scale restoration projects supports the Panel's discomfort; often the general descriptions of restoration plans are much more optimistic and grandiose than the actions that are actually implemented.
338	Hamilton	p. 51, para 2, line 1	*'This is a weak conclusion and unsatisfactory to the Panel'* Which is it? As discussed in preceding paragraph on pg 51, or weak? Do you mean "However" here?	The report has been revised in response to this comment.
339	Hamilton	p. 51, para 2, 1.	~~Steelhead are good swimmers.~~ Do you mean that 'Steelhead use tributary habitat to a greater upstream extent than salmon (Platts and Partridge 1978)'	The Panel meant the ability of steelhead to migrate through turbulent and less than optimal habitat.
340	Hamilton	p. 51, para 2, 4.	Add: Steelhead are more resistant to disease. (ALJ Decision at 22, FOF 2B-18 and 2B-19)	The report has been revised in response to this comment.
341	Hamilton	p. 51, para 4, line 7	*e.g., Huff 2005; Rodnick et al. 2004*), There are other citations on temperature tolerance steelhead up to 24^{o}C. (Moyle 2002) p. 272	The Panel responds that two citations are sufficient for this report.
342	Hamilton	p. 52, para 2,	*'Poor water quality in Keno Reservoir and in Upper Klamath Lake, and the possibility of difficulties in passage at Keno and Link*	The report has been revised in response to this comment.

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		line 1	*dams, could prevent steelhead from reaching improved habitat upstream of the Project Reach.'* This ignores the seasonal application of Trap and Haul and does not make it clear that WQ problems are seasonal.	
343	Hamilton	p. 52, para 2, line 8	*'Some evidence suggests that O. mykiss' shows signs of migratory behavior'* Both steelhead and redband are *O. mykiss*, use subspecies name. There is ample evidence that redband need to migrate. FERC (2007) 3.3.3.1.6 Resident Fish Species-rainbow trout (p. 3-242) Most of the trout in [the Keno Reach] spawn in Spencer Creek. In 1991, Oregon Fish & Wildlife collected 1,813 adult rainbow trout at a weir constructed across Spencer Creek, with peak upstream movement observed in April. During outmigrant trapping, a total of 4,218 fry and 25,618 juvenile rainbow trout were collected. Peak downstream movement of fry occurred in August and September, while the peak movement of juveniles occurred in May (Buchanan et al., 1991). (Jacobs et al. 2008) Redband trout *Oncorhynchus mykiss newberrii* life histories range from headwater populations that complete their life cycle within a few kilometers of their natal stream to fluvial and adfluvial populations that migrate extensively over their life cycle to use riverine and lake habitats (Behnke 1992; Buchanan et al. 1994) See -(Tinniswood 2007), (Gerstung 2007), Messmer and Smith (2007)- for examples of local redband trout migrations and	The report has been revised in response to this comment.

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			colonization. These reports are all found in- 'Redband Trout: Resilience and Challenge in a Changing Landscape', Oregon Chapter, American Fisheries Society http://www.orafs.org/marketplace.htm	
344	Hamilton	p. 52, para 2, line 6	*'If the habitat added or improved is sufficient to affect steelhead,…'* Wouldn't having dams out provide another option for *O. mykiss* and increase the number of life histories available to species and populations?	This comment is noted. The Panel responds that the answer to the commenter's question is, maybe.
345	Hamilton	p. 52, para 2, line 14	*The combined effects of these issues (i.e., over the entire life cycle) are unknown.* These subspecies co-existed and evolved with each other for eons. Kiffney et al. 2008 found overall biomass increased when both resident and anadromous together.	The report has been revised in response to this comment.
346	Hamilton	p. 52, para 3, line 8	*'Assessing the success of fish passage at the dams is currently possible. Water quality monitoring of the Upper Klamath Lake can at least determine if stressful conditions exist.'* There is ample information but appears to be overlooked. See Dunsmoor and Huntington 2006; also see Maul et al. 2009)	The report has been revised in response to this comment.
347	Hamilton	p. 52, para 3, line 13	*The interactions between steelhead and other O. mykiss could be predicted through experimentation and modeling, but it is complicated.* Again, recommending monitoring/research. This is beyond the	See response to comment 233

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			scope of the questions. *Small pieces can be addressed before dam removal, such as whether existing O. mykiss populations produce migratory smolts that attempt to pass through Link Dam.* This is beyond the scope of the questions.	
348	Hamilton	p. 53, 3.10 restated question	*'...more specifically physical habitat and food?* This may be misinterpretation of the question. Ecosystem function is broader than habitat and food!	The Panel responds that the comment is true, but these are the main aspects of ecosystem function not addressed in the other sections of the report.
349	Hamilton	p. 53, Discussion, para 2, line 2	*'Although usually posed more broadly, we apply this definition of ecosystem function narrowly to include those attributes of the riverine and riparian ecosystems necessary to support salmonid populations, including physical habitat but also adequate food, some protection from predators, low incidence of disease, adequate water quality, non-stressful temperatures, and minimal exposure to toxins.'* The intent of the questions had to do with a much broader definition of ecosystem function. This includes hydrology, sediment transport, and riparian zones. This applies to Klamath River below IGD as much as above. Refer to Hetrick et al. 2009.	See response to previous comment. The Panel responds that hydrology, sediment transport, riparian zones (i.e., physical habitat) are addressed in responses to other questions and did not see the need to repeat that information here.
350	Hamilton	p. 54, para 2, line 3	*'...is severely limited within the Keno Dam to Shasta River reach...'* Don't you mean IGD to Shasta River reach? Anadromous habitat that is inaccessible is IGD to Keno. Panel seems to be confused about Keno and IGD and the current	The report has been revised in response to this comment.

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			distribution of anadromous fish	
351	Rondorf	p. 53, Para 4:	*"Conditions Without Dams and with KBRA; …but opportunities exist to improve the state of knowledge on this topic."* Identifying opportunities to improve the state of knowledge was not specifically in the scope of work for the Panel. However, this is an important benefit from the deliberations of the panel. Deleting the reference to the state of knowledge in this answer and placing it in an "afterword" or "epilogue' section of the report on the opportunities for advancement of knowledge in the coming years between 2012 and 2020 would be a more appropriate and effective location for this message.	The report has been revised in response to this comment.
352	Hamilton	p. 54, para 2, line 6	*'will be small'* The report uses vocabulary of certainty here, but only uses the words 'likely' or 'could' for characterizing effects on steelhead. See 3.7	The report has been revised in response to this comment.
353	Hamilton	p. 54, para 4, line 5	*Upper Klamath Lake.* See info in Dunsmoor and Huntington 2006; also see Maul et al. 2009). Again, seasonal trap and haul may be employed around UKL under KBRA (see appendix 2c).	The Panel received a variety of information about plans for trap and haul.
354	Hamilton	p. 54, para 4, line 12	*'The agencies seem to be relying on being able to facilitate access to the upper basin with a lengthy trap-and-haul program to transfer fish into the upper basin if the fish cannot get there unaided.'* No this this would be trap and haul around Keno (and possible UKL) only. It would be seasonal only.	The report has been revised in response to this comment. The Panel asks what is the difference between "to the upper basin" and "around Keno (and possible Upper Klamath Lake) only." "Lengthy" has been deleted from the text of the final report.

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355	Hamilton	p. 55, para 1, line 3	*"appears"*	The Panel is not clear as to what the comment is referring to.
356	Hamilton	p. 55, para 1, line 13	*'we recommend an investigation into the food quantity, quality, and availability, bioenergetics constraints to accessing and using this food, and habitat use by the various fishes expected to occupy different habitats in the upper river.'*	The Panel is not clear as to what the comment is referring to.
357	Hamilton	p. 55, w/o dams and with KBRA	*'can result both in reductions and increases in disease incidence.'* Refer to Panel presentations from Josh Strange at coho/Chinook panels; Scott Foott at coho/Chinook panels; and Bartholomew at Chinook panels. Information is also provided in the Hamilton et al. (synthesis) document (Hamilton et al. 2010), in particular Table 3 and associated citations. Further information is provided in the peer reviewed 'Compilation of Information Relating to Myxozoan Disease Effects to Inform the Klamath Basin Restoration Agreement' (Bartholomew and Foott 2010).	See response to comment 242.
358	Hamilton	p. 55, discussion, line 4	*'parasitized but rarely impaired (Stone et al. 2006)'* Note that disease is seasonal in severity; it does not affect all salmon outmigrants.	This comment is noted.
359	Hetrick	p. 55	Restoration of the hydrologic function of the river system is paramount to creating habitat diversity and maintaining biophysical attributes of a river system (Stanford et al. 1996; Poff et al. 1997). Although implementation of the Agreements will not fully restore the natural hydrologic regime of the Klamath River, it would result in a flow pattern that mimics pre dam conditions, having greater intra- and inter-annual variability than	The Panel based their deliberations on the flow modeling results provided to the Panel.

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			exists today. Creating diversity in flows and water temperatures and providing flexibility to manage flows to respond to real-time climatic and biological conditions (discussed in Section VI) will be made possible by the KBRA. Restoring these dynamic conditions in the Klamath River will create instability and disturbance in microhabitat conditions that would be expected to reduce polychaete populations (Stocking and Bartholomew 2007) and presumably, reduce infection rates within polychaete populations. The stable, monotypic, nutrient- and diatom-rich flow conditions that occur immediately below IGD provide an optimal environment for production of filter-feeding benthic invertebrates such as M. speciosa (Wilzbach and Cummins 2007). Fluctuating flows that mimic, albeit to a lesser degree, conditions experienced under a natural flow regime, would mimimize the occurrence of monotypic stable flow conditions in which polychaete worms are known to proliferate. The concept of mimicking the shape and function of the natural hydrograph in response to changes in environmental conditions is widely accepted as the most ecologically defensible approach to managing flows (Stanford et al. 1996; Poff et al. 1997; Richter et al. 2003). Under the KBRA, the Technical Advisory Team would have flexibility to integrate flow variability and natural flow-induced disturbance into management of the Klamath River.	
360	Hamilton	p. 56, para 4, line 1	*'slight elevation in Upper Klamath Lake and Keno Reservoir'* Please Explain	The Panel refers the commenter to the source document for an explanation.
361	Hamilton	p. 57, para 1	*'spreading of the disease above the dams.*	The Panel responds that the information provided by the

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			This will be strain specific. See Bartholomew, J. L. and J. S. Foott (2010). "Compilation of Information Relating to Myxozoan Disease Effects to Inform the Klamath Basin Restoration Agreement." *Steelhead ~~is~~ are resistant to* *The risk of unintended consequences seems high.* These species and diseases existed above IGD historically for eons.	commenter is discussed in the report. The report has been revised in response to this comment. This comment is noted.
362	Hamilton	p. 57, para 2, lines 5 and 7	*The degree of this removal needs to be determined experimentally or with field-based flow and sediment manipulation studies.* *This speculation could be tested experimentally by the introduction of gravel into a reach of the river with high polychaete abundance and monitoring before and after subsequent floods, particularly experimental floods designed to increase peak flow over that seen in recent years.* Beyond the scope of the questions.	See response to comment 242.
363	Hamilton	p. 57, para 3	What about assimilative capacity of a free running river to reduce nutrients?	The Panel refers the commenter to the discussion on "adequate water quality" in the final report.
364	Hamilton	p. 57, para 5, line 9	*Colonization of steelhead in tributaries upstream of Klamath Lake could introduce C. ~~S~~ shasta to resident O. mykiss if steelhead migrate.*	The report has been revised in response to this comment. The Panel responds that the resistance of steelhead is why they can be

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			Resident *O. mykiss* in areas accessible to anadromous fish are resistant. FERC (2007) p.3-226-Klamath River steelhead are relatively resistant to ceratomyxosis. p.3-242-Upper Klamath Lake supports a population of large rainbow trout, which appear to be adapted to harsh water quality conditions and resistant to the endemic protozoan *C. shasta,* which causes high rates of mortality in non-resistant strains of rainbow trout. (ALJ 2006)USFWS/NMFS Issue 2(C) Discussion p.61	found in reservoirs. The *O. mykiss* referred to by the Panel is redband, not steelhead.
365	Hamilton	p. 58, first sentence	*Colonization of steelhead in tributaries upstream of Klamath Lake could introduce C. Shasta to resident O. mykiss if steelhead migrate to the headwaters where resident trout live. These headwater resident O. mykiss, which do not intermingle with adfluvial O. mykiss, are highly susceptible to C. shasta (see Resident Fish Expert Panel report).* The question asked was: 'How will the two alternatives differ in incidence and impact of diseases in coho and steelhead?' We did not ask about disease effects to resident fish. Again, this is another example of unnecessary opinions offered that are beyond the scope of the questions. FYI, This was addressed on pg 25-27-'Genetics' and 'Disease' and section 3.2.5 'Effects of Genetics' (pg 65) in Resident Fish Expert Panel report. The Panel may not be aware that water falls exist on Jenny Creek and the Williamson River below Klamath Marsh preventing upstream migration of anadromous fish into headwater reaches where remnant susceptible populations are located.	See response to comment 233.

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366	Hamilton	p. 58, w/o dams and with KBRA	*If hatchery production ceases, fitness of natural origin populations might improve, but overall population size and harvest might decline.* Hatchery returns for steelhead are almost non-existent (Chesney 2000) California Department of fish and Game 2010; how could they decline?	The Panel responds that the question was specific to coho.
367	Hamilton	p. 58, discussion para 3, line 2	*'which is what is necessary if it is to support a sustainable fishery in the absence of a hatchery.'* Please provide a cite to support this statement.	The Panel responds that the text here goes on to explain this rationale. The Panel refers the commenter to Table 8.
368	Rondorf	p. 58, Para 7:	"Approximately 0.58 million yearling coho………ESU and are also protected by the ESA." The above paragraph does not indicate the purpose of the Iron Gate Hatchery production, mitigation for dam and reservoir construction	The report has been revised in response to this comment.
369	Hamilton	p. 61, para 4, line 10	*'Essentially all harvests of coho salmon occur in the Trinity River, which has a large hatchery.'* Please provide a cite to support this statement.	The report has been revised in response to this comment.
370	Rondorf	p. 62, Table 8:	R/S is not explicitly defined in the title of the table.	The report has been revised in response to this comment.
371	Hamilton	p. 62, 3.13 discussion	Same comments on the Executive Summary.	The report has been revised in response to this and other comments.
372	Hamilton	p. 62, 3.13	*'the possibility of small improvements'*	This comment is noted.

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		discussion, para 1, line 6	See Dunsmoor and Huntington 2006	
373	Rondorf	p. 62, Para 4:	*"Discussion: Compared to conditions with Dams, the Conditions without Dams and with KBRA alternative offers a potential for more improvement in the recreational fishery."* The above topic sentence from the first paragraph of the discussion is much more clear and definitive than the summary answer. This sentence would add clarity to the summary answer where the Panel finds the effectiveness of KBRA, fate of hatcheries, and harvest policy are insufficiently defined.	The report has been revised in response to this comment.
374	Hamilton	p. 63, 3.14.1 restated question	*recovery of ESA-listed fish* Not our question. Another example of discussion that is beyond the scope of the questions.	The report has been revised in response to this comment. The Panel notes that harvest of coho will require recovery first.
375	Rondorf	p. 63, Sec 3.14.1	*"Habitat Restoration (KBRA) (G-4)"* Inasmuch as there are no summarized answers associated with this section the reader would benefit from the discussion being relocated in the report. The discussion has valuable insights from the Panel and should be associated with the summarized answers for that topic.	This comment is noted.
376	Hamilton	p. 64, para 3, line 9	*introgression by hatchery steelhead* Returns of hatchery steelhead are very low (Chesney, 2000; California Department of Fish and Game 2010).	The report has been revised in response to this comment.
377	Hamilton	p. 64, para 3, line 12	*'introduction of disease to trout in tributary headwaters.'* *These headwater populations are generally above the historical distributions of anadromous fish (Hamilton et al. 2005; see the 'Extent of Upstream Distribution' sections). The Panel may not be aware that natural blockages (water falls) exist on Jenny*	The report has been revised in response to this comment.

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			Creek, the Williamson River below Klamath Marsh, and other locations preventing upstream migration of anadromous fish into headwater reaches where remnant most populations are located. *Natural blockages would maintain the diversity referred to.* *Below these natural barriers, historically these populations coexisted for eons.*	
378	Hamilton	p. 65, para 1, line 2	*This is less likely to help coho* Again, would increase coho spatial structure	The report has been revised in response to this comment.
379	Hamilton	p. 65, discussion para 1, line 2	*'The high-velocity'* This is an over generalization. While gradient may be high, there are currently large step-type pools in J.C. Boyle Reach. John Hamilton can provide photos if interested.	The report has been revised in response to this comment.
380	Hamilton	p. 65, discussion para 2, line 1	*It is unlikely that either of the two alternatives will substantially mitigate the adverse effects of climate change on coho.* What about steelhead?	The Panel responds that steelhead are also discussed in this section of the final report.

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381	Hamilton	p. 67, para 3, line 3	*'since temperature of spring and groundwater input to rivers typically approximates mean annual air temperature,'* This assumption needs a citation.	The Panel responds that it is a general world-wide approximate rule for well-understood physical reasons. Temperatures are slightly warmer in volcanic and tectonically active regions, but when the Panel inserted the relevance of that statement for the lower Klamath, one of the reviewers above did not like that either.
382	Hamilton	p. 68, first sentence	*'augmentation through KBRA being sufficient to mitigate temperature increases driven by global warming.'* KBRA has provision for 30,000 acre feet of additional water.	The report has been revised in response to this comment.
383	Hamilton	p. 68, para 2, line 3	*already very low (~2 percent)* Is this based on hatchery fish?	The report has been revised in response to this comment.
384	Hamilton	p. 68, para 2, line 10	*monitoring of juvenile production from freshwater habitats will be necessary to evaluate the effectiveness of salmon habitat projects in the Klamath Basin.* So, how do the two alternatives compare?	The Panel responds that the comparison is contained in the summarized answers and elaborated on in the rest of the report sections.
385	Rondorf	p. 69, Sec 4.0: "References"	Numerous references cited in the discussions of the report are missing from the reference section.	The report has been revised in response to this comment.
386	B. Trush	(none provided)	Depending on who is reading the Panel's report, a 'small' short-term improvement for coho salmon (Draft Report Executive Summary, page ii) can be considered highly significant or highly	The Panel agrees with this comment. The report has been revised in response to this

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			insignificant. I think 'small' will be highly significant long-term, notwithstanding the scarcity of data and analyses, if for no other reasoning than establishing multiple life history tactics throughout the Klamath River Basin better hedges the future, than one or a few. Perhaps the Panel could add more definition/qualification to 'small'?	comment.
387	B. Trush	(none provided)	Elimination/curtailment of disease in the Klamath River mainstem should take precedence over increasing/worrying-about mainstem spawning habitat capacity or mainstem juvenile rearing habitat capacity. The Panel could not conclude dam removal would reduce disease impacts. Presently, this problem is extremely complex; when we look backward someday, it might appear otherwise. More than the Panel's brief introduction to this issue, and subsequent analyses (if any), would be needed to generate the insight necessary to solve this challenging puzzle or even to frame the right questions. A first step would be to go back to the unregulated, natural annual hydrograph and integrate all the biological pathways. The KBRA does an extremely poor job of incorporating daily average annual hydrographs into mainstem instream flow analyses and recommendations (e.g., still using mean monthly streamflows). Yet the inter-annual variability, not captured by mean monthlies, may be the key to addressing disease. For instance, the location of Iron Gate Dam is at the Basin's transition (1) from snowmelt to rainfall dominated annual hydrographs and (2) from high spring and summer baseflows sustained by springs to sharply receding summer baseflows typical of coastal, rainfall dominated hydrographs. These hydrologic transitions should be important to the puzzle.	The Panel thanks the commenter. The Panel responds that if these difficult problems are to be solved, and the "right" choices made, it will be necessary to acknowledge the complexity, address the uncertainties and, as you say, go back to basics to try to understand all aspects of the issues. Unfortunately the Panel has been beset with passionate opinion (plus or minus) about what will happen and have been in the difficult position of trying to tease out that which is scientifically based from that which is based on personal interests or preferences.
388	B. Trush	(none provided)	Improved overall river ecosystem vigor, as in highly productive riffles for benthic macro-invertebrates with favorable springtime	The Panel was charged with questions about coho and

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			and early-summer water temperatures, also should take precedence over habitat capacity concerns.	steelhead. Ecosystem functioning was also a question and some of the information about functioning versus fish habitat can be found in that section in the report. However, the focus of the Panel deliberations was on coho and steelhead.
389	B.Trush	(none provided)	Unfortunately, productivity and ecosystem integrity are not as easy to quantify (or at least think we are quantifying) or valued (curiously) as salmon habitat capacity. Expecting the mainstem of a big regulated river to take-on the ecological roles of its headwater mainstem channel and tributaries, now isolated by a big dam, is wishful.	This comment is noted.
390	B. Trush	(none provided)	If a ROD is needed on the Trinity River, then the Panel's response in Table ES-1 for Ecosystem Function is less than convincing: "The information available on the details of the KBRA is insufficient to answer the question, but opportunities exist to improve the state of knowledge on this topic." The Panel can be much more explicit, without requiring intimate familiarity with the Klamath River data and analyses, to stress just how important attention to 'ecosystem function' really is.	This comment is noted.
391	B. Trush	(none provided)	Dam removal will open the door to innovative solutions, even if data and the existing integration have not provided a convincing trail. However, a stronger assertion that the future will require options is needed from the Panel.	The Panel discussed the need for flexibility and targeted modeling and data collection into the future. Indeed, other commenters said these discussions were out of scope.
392	B. Trush	(none provided)	The Executive Summary hints, but offers no resonating answer, to the question: Would keeping the dams guarantee failure?	The report has been revised in response to this comment. The Panel responds that, of course, the

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				Panel could not answer that exact question, and as many of the comments suggest its task was to compare the two alternatives. Some text has been added to the executive summary of the final report to clarify.
393	P.Higgens (Resighini Rancheria Tribe)	p. 38, second paragraph	**Water Quality Problems Not Solved by KBRA** The Panel recognizes the major problems with water quality, but would have been better informed had they been provided the *Water Quality Control Plan Hoopa Valley Indian Reservation* (Hoopa TEPA 2008), which explains the complex mechanisms of Klamath River water quality impairment. In addition to temperature, dissolved oxygen, ammonium and toxic algae recognized by the Panel, elevated pH caused by nuisance algae blooms can be directly stressful to coho salmon and steelhead (Wilkie and Wood 1995). Elevated pH also combines with warm water temperatures to convert ammonium ions to dissolved ammonia (Goldman and Horn 1983). Not only did the Panel overlook pH as a stressor, it also neglected the topic of synergistic action of multiple water quality stressors lowering coho salmon and steelhead resistance and increasing their susceptibility to diseases. The Panel characterized dissolved oxygen (D.O.) problems as follows: "Depression of dissolved oxygen in Upper Klamath Lake and the reservoirs is due to elevated oxygen demand caused by high levels of organic matter, mainly due to production by algae (Doyle and Lynch 2005) and to some	The report has been revised in response to this and other comments. The Panel discussed the difficulties in improving water quality in view of the high natural nutrient loading and non-point-source anthropogenic inputs. In addition, the Panel noted some potential barriers to sufficiently solving the disease problem.

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			extent high ammonium concentrations (Sullivan et al. 2010)" (p. 38). What isn't stated here is that major sources of nutrients causing anoxia in Keno Reservoir are also coming from the lower Lost River, Tule Lake and the bed of Lower Klamath Lake. Winter water from the Lost River is pumped into the Klamath River below Klamath Falls, Oregon (Deas and Vaughn 2007) and has the potential to add to sediment oxygen demand. In summer, drain water from Tule Sump and industrially farmed areas in Lower Klamath Lake is emptied directly into Keno Reservoir through the Straits Drain. Keno Reservoir not only went anoxic from 1996-1998, it continued to do so annually from 2001-2005 (Deas and Vaughn 2007).	
394	P.Higgens (Resighini Rancheria Tribe)	p. 39, first paragraph	**Water Quality Problems Not Solved by KBRA (cont.)** The Panel also pointed out the need for a major, strategic reduction in nutrients: "Experience from other locations where eutrophication is a major problem suggests that, at a minimum, drastic reductions in loading from the watershed must accompany local amelioration. These reductions must account for the apparently high natural nutrient inputs from the local watersheds, and the unavoidable leakage occurring in watersheds heavily altered for urban and agricultural use. Thus, it would be premature to conclude that any problems caused by these blooms, including low dissolved oxygen, will be substantially reduced by KBRA" (p. 39). The Lost River Basin was a sink, ending at Tule Lake, and not	The information referred to by this commenter is what led the Panel to express its frustration with the lack of details in the KBRA. The Panel was charged with fish-centric questions about coho and steelhead. Other commenters were of the opinion the Panel exceeded its charge with it current discussion about water quality.

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			connected to the Klamath River historically, but today all its wastes are exported to the Keno Reservoir reach. The KBRA gives agricultural interests the right to continue to farm on 22,000 acres of the Tule Lake and Lower Klamath Lake National Wildlife Refuges for 50 years or through 2062. There is no similar arrangement on any other refuge system in the nation and these publicly owned lands need to be restored to lake and marsh systems to meet intended wildlife conservation benefits to reduce pollution, increase natural nutrient assimilation, decrease water demand, and to increase water storage. Without such strategic action, algae blooms will still be a huge problem in the lower Klamath River and water pollution will be an equal or even greater stressor on juvenile salmon and steelhead. Asarian et al. (2010) found that dam removal will actually result in a substantial increase in total nitrogen (TN) at the current location of Iron Gate Dam and a modest increase in total phosphorous (TP) because they will no longer settle out in reservoirs. This recent finding makes an even stronger case for reducing nutrients in the Upper Klamath Basin at their source.	
395	P.Higgens (Resighini Rancheria Tribe)	p. 38, fifth paragraph	**Water Quality Problems Not Solved by KBRA (cont.)** Conversion of marsh land around Upper Klamath Lake has provided ample phosphorous for plant growth and caused nitrogen to become more limiting. The nitrogen fixing blue-green algae *Aphanizomenon flos aquae* colonized Upper Klamath Lake after WW II (NRC 2004) and can transform nitrogen gas from the air into a form usable by plants. Agricultural water supply through the A Canal continually inoculates the Lost River and Tule Lake with this nitrogen fixing species. Research indicates that mild acids from decaying material within marshes	See response to comment 394.

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			causes *A. flos-aquae* cells to break down (ASR/WRC 2005, WRC 2009). Therefore, marsh restoration is needed to stop nitrogen fixation that is a major source of pollution throughout the Upper Klamath Basin. "The description provided to the Panel (Barry et al. 2010) says the restoration is 'Likely to be combination of treatment wetlands, engineered water treatment facilities, physical removal of particulate organics, treatments to precipitate nutrients (alum, clay, etc.). Cost certain to be large, precise estimates will follow appropriate studies'" (p. 38). The technical approach embraced by the KBRA will not likely be sufficient and the cost of treatment and/or pumping associated with such actions is likely to be prohibitive. The greatest likelihood of success would be to restore the natural water storage and water filter capacity of the Upper Klamath Basin, or some portion thereof, as it existed prior to disturbance. As marshes within the lower Lost River and Keno Reservoir riparian zone and Tule and Lower Klamath lakes were restored, they would reduce sources of pollutants and water demand and instead act as nutrient assimilation and cold water storage systems. They would also be fed by gravity and natural flow patterns that do not require constant expenditure of energy or on-going subsidy. Laetz et al. (2009) recently found that coho salmon juveniles were very susceptible to combinations of pesticides at low levels due to synergistic effects and the Resighini Rancheria is concerned that this issue is not even addressed in the KBRA or the Expert Panel coho and steelhead report.	

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396	P.Higgens (Resighini Rancheria Tribe)	p. 26, various pertaining to water quality and flow regime.	**Ecosystem Function Not Restored by KBRA** The Panel comments on ecosystem function focus on food production and competition with native trout, but fail to look at landscape scale questions with regard to re-establishing the equilibrium of flow and nutrient inputs with which coho salmon and steelhead co-evolved. For example, the Lost River where much of the Klamath Project is located was never joined to the Klamath River historically and the large export of nutrients into the Keno Reservoir is far beyond the capacity of the system to assimilate. The Panel repeatedly refers to the Klamath River as "naturally" nutrient rich, but the ecosystem was still extremely productive because of the natural buffer and filter capacity of the marshes and lake systems. Hundreds of thousands of acres of marsh and lakes in the Upper Klamath Basin have been converted to agriculture; the question is how much needs to be restored to marsh to re-establish this balance. The Panel points out in discussion of flow that patterns were much different before Lower Klamath Lake was disconnected and the inception of the Klamath Project and their Figure 3 is adapted for use here (Figure 1). The clear departure of flow patterns from historic levels with which salmon and steelhead co-evolved is in itself another manifestation of failure to restore ecosystem function. This artificially low flow regime fosters increased temperature, increased nutrient concentrations and conditions that help increase pathogens in the river. The KHSA and KBRA will move the river further from its historic range, not closer to it; therefore, these agreements will not heal the river. If Lower Klamath Lake were refilled, it would increase water storage and move the lower Klamath River flow towards its	The Panel stated that changes in flows would be small under dams-out with KBRA.

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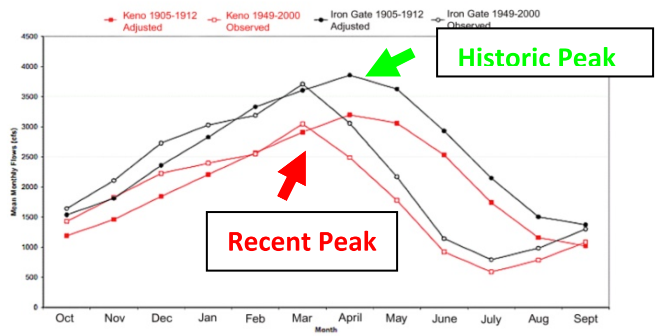
			historic norm, eliminate a large nutrient source and restore assimilative capacity it so badly needed to offset contributions from the Lost River.  **Figure 1. Chart of historic seasonal flows versus those after the construction of the Klamath Project and the disconnection of Lower Klamath Lake with annotations on peaks added. Taken from the coho and steelhead Expert Panel draft report where it occurs as Figure 3.**	
397	P.Higgens (Resighini Rancheria Tribe)	Various pertaining to TMDL implementation and off-topics.	The Indian People of the Klamath River Basin have harmony based cultures that believe themselves and all the other living things to be a seamless part of the river. For the river to function properly and continue as a living system, all native aquatic organisms should be able to flourish. While the Lost River and short-nose suckers of the Upper Klamath Basin were covered by a previous KBRA/KHSA report and process, we believe the coho and steelhead expert Panel should have recognized them as an indicator species. The NRC (2004) recommended that Lower Klamath Lake be filled to establish an additional population center for suckers. In addition, the NRC (2004) also notes that the lower Lost River and Tule Lake were	The Panel was charged with addressing coho and steelhead. The Panel responds that this comment should be directed to those who decided on the organization of panels around fish species.

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			once the most important areas for Native American fishing because of the abundance of suckers. These areas also need to be restored to a suitable condition for suckers under the Endangered Species Act and the Clean Water Act and yet under the KBRA the Lost River is to remain compromised until at least 2062. As a consequence, the pollution exported from this area will continue to push the Klamath River over the tipping point from nutrient enriched to nutrient polluted and the ecosystem will exhibit continuing non-normative function. The Panel invokes the Klamath River TMDL (NCRWQCB 2010) as having the potential for helping abate water pollution in conjunction with the KBRA. The Klamath TMDL is conjoined to the Lost River TMDL, which also includes Lower Klamath Lake. The Lost River and short-nose suckers are beneficial uses under the CWA and, therefore, need to be restored in these locations. However, continued farming on the Lease Lands in the Tule Lake and Lower Klamath Lake National Wildlife Refuges will not allow either sucker or water quality recovery by 2062, thus, the KBRA actually blocks successful TMDL implementation. If suckers were thriving in these locations, Keno Reservoir would no longer exhibit anoxia and the balance of a properly functioning Klamath River ecosystem would be restored.	
398	P.Higgens (Resighini Rancheria Tribe)	p. 54, last paragraph, various pertaining to restoration and freshwater survival.	The Panel recognizes that failure by the KBRA to abate water pollution in Keno Reservoir and Upper Klamath Lake and instead relying on trapping and hauling for fish passage constitutes an "open-ended retreat from ecosystem restoration goals." Kier Associates (1999) chronicled some success with riparian restoration in the Shasta and Scott River basins, but also noted that depleted flows were confounding restoration success. Van Kirk and Naman (2008) showed that increased groundwater	This comment is noted.

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			pumping was depleting surface flows in the Scott River basin to well below historic norms. There is an attendant decrease in water quality and suitability for salmonids (QVIC 2008a). NRC (2004) pointed out that spring flows that historically provide ideal conditions for salmonids in the Shasta River had been cut off and diverted for agriculture and domestic water supply. They recommended restoring flows to decrease transit time and thereby alleviate temperature problems in the Shasta River. The Shasta River TMDL (NCRWQCB 2006) calls for an increase in flows to restore water quality, but no action has been taken or is currently planned. The California Department of Fish and Game (ESA 2009a, 2009b) incidental take permits (ITP) issued for the Scott River and Shasta River will not address flow problems (QVIC 2008a, 2008b). Therefore, additional expenditures of KBRA funds in these basins will not restore ecosystem function. The Panel discusses the small cold water islands at the mouths of Klamath River tributaries and in their lower reaches and suggests modeling exercises related to their carrying capacity. The refugia are the last viable patches of habitat, and surely they must be protected, but the juvenile coho that utilize them should actually be able to rear in the Shasta River and Scott River all year long, if their flows were restored. This would help achieve the two to four-fold increase in freshwater survival the Panel said was needed for coho salmon to flourish into the future and provide a source of colonists for habitat opened up by dam removal.	
399	P.Higgens (Resighini Rancheria Tribe)	p. 18, fifth paragraph, various pertaining to water quality	**Water Quality Monitoring** The Panel was disappointed that the KBRA did not have a defined water quality plan and offered the following (emphasis	The Panel had to work with the information provided. The relationship among other water quality programs and the KBRA was too vague at this time for the Panel

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		and TMDL.	from their report): "Monitoring programs should be planned, coordinated, and implemented now for effective and timely detection of the consequences for the salmon of the grand experiment comprising the dam removal and KBRA program. A monitoring program should be designed and established as soon as practicable to provide useful and timely guidance for KBRA and the design of dam removal" (p. 18). If the KBRA were really coordinated with the TMDL, and its objective was to abate water pollution, then the water quality standards within the TMDL, the North Coast Basin Plan (NCRWQCB 2007) and the Water Quality Control Plan Hoopa Valley Indian Reservation (Hoopa TEPA 2008) should have been adopted as program targets. Trend monitoring of these parameters at strategic locations along the river before and after dam removal would provide information on which to base adaptive management. Target dates for compliance need to be relevant to Pacific salmon recovery (10 years).	offer specific advice on mutual or exclusive targets, and this would have been outside the Panel's charge.
400	P.Higgens (Resighini Rancheria Tribe)	Various pertaining to flow and habitat for coho.	**Effects of Hatchery Operation Versus Habitat Loss on Coho Salmon Productivity** The Panel ascribes low stock productivity in the Shasta River to introgression of non-native traits into the population, when in fact the low survival is as a result of a habitat collapse. While the Panel used information from Bill Chesney of the CDFG on low survival of coho salmon in the Shasta River, they may not have been in receipt of the report *Shasta River Juvenile Coho Habitat and Migration Study* (Chesney et al. 2009). This report indicates that some of the last springs in lower Parks Creek are being dried	This comment is noted.

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			up directly resulting in loss of coho juveniles. Long term Shasta Rack counts document wild coho salmon trends (QVIR 2006) and the Scott River has consistent, widespread wild coho salmon spawning (Maurer 2002, 2006). The extreme flow depletion in these basins has driven coho to the brink of extinction in these basins, not stray hatchery fish.	
401	P.Higgens (Resighini Rancheria Tribe)	Various pertaining to climate change, habitat, flow, and water quality for coho and steelhead.	The Panel clearly describes the changes in precipitation and ocean conditions attendant with the Pacific decadal oscillation cycle (PDO) and documents on-going climate change effects in the Klamath Basin such as increased snow elevations, decreased spring flows, and highly variable precipitation. The switch of the PDO to dry on-land and poor ocean productivity in 1975 was followed by the 1976-77 drought and the record inter-annual drought from 1986-1992 also came during this cycle. This means that there will likely be an equal or more severe series of droughts after the predicted PDO switch sometime between 2015-2020 (Collison et al. 2003). There are empirical data not put before the Panel that show that coho and steelhead habitat is drying up and that acute nutrient pollution is causing a cascading downward ecological spiral in the Klamath River that now includes toxic algae. The KBRA should have followed a "best-science" approach to ecosystem restoration as described by Bisson et al. (2009): "Management of the freshwater habitat of Pacific salmon should focus on natural processes and variability rather than attempt to maintain or engineer a desired set of conditions through time." The KBRA attempts to use technical fixes and energy intensive engineering approaches to restoration while failing to deal with	This comment is noted.

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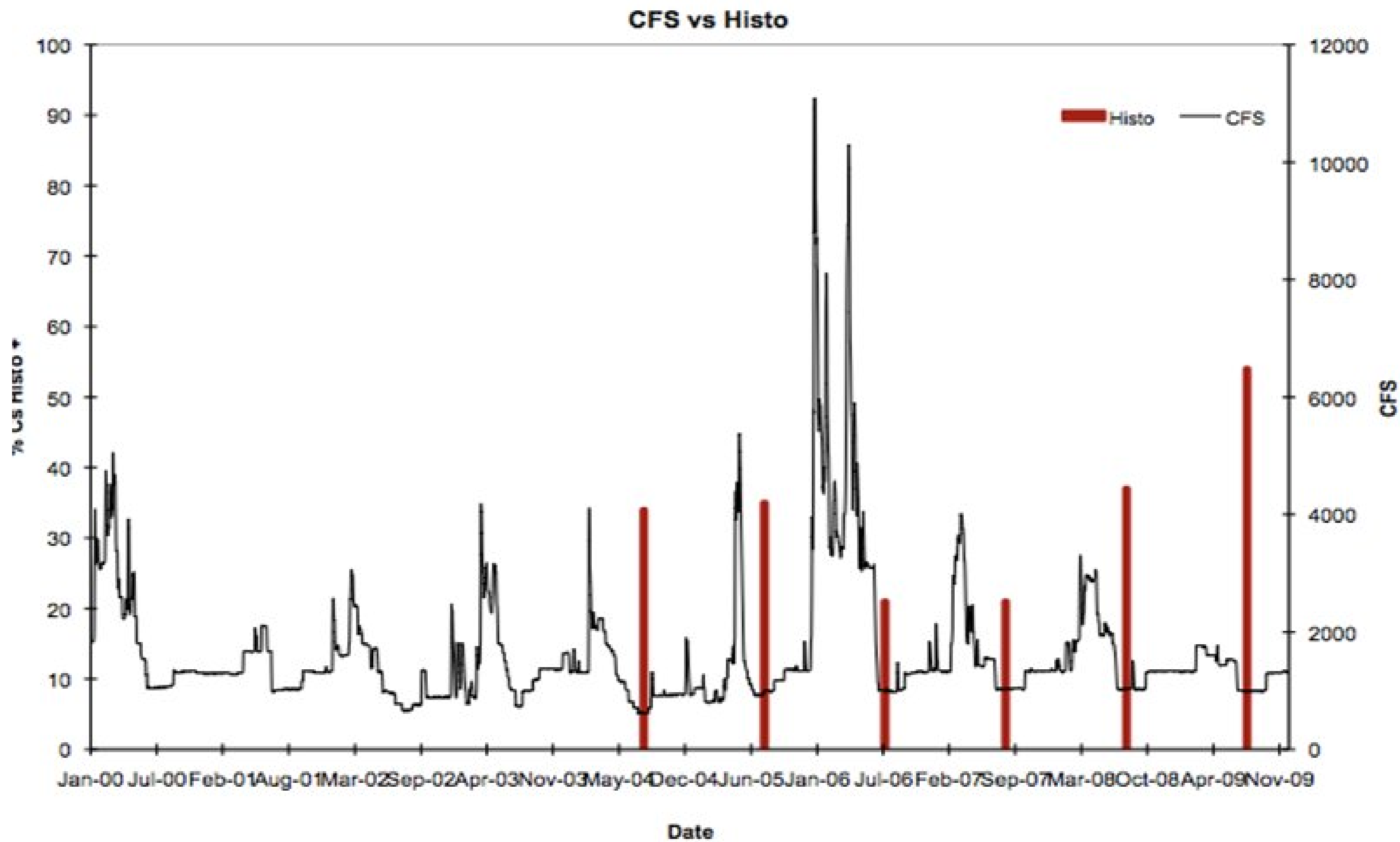
			the fundamental problems of flow and nutrient pollution. The Panel states that "The processes, controlling factors, and hazards likely to have the greatest influence on project outcomes should be identified ***now***" (emphasis in report). The KBRA needs to be modified to deal with the reality that dam removal increases nutrients and to abate pollution and restore natural water storage and purification systems upstream or poor Klamath River fish health and low juvenile survival will continue.	

Tables and Figures for Yurok Comment 149 (Myxozoan Disease Discussion)

Table 1. Effects matrix showing likely outcomes of the two scenarios of major C. Shasta life cycle factors.

C. shasta **life cycle**	**Status Quo Dam In**		**KBRA Dams Out**	
factor	**score**	**Comments**	**score**	**comments**
polychaete abundance	-	favored habitat enhanced, geomorphic/flow stability, and diet	+	some new habitats available, favored habitat degraded with geomorphic/flow instability increased and phytoplankton diet reduced
polychaete diet	-	continued enrichment by phytoplankton from reservoirs and elevated nutrients increasing epiphytic algae for diet and habitat	+	phytoplankton associated with reservoirs reduced or eliminated, reduced nutrients and epiphytic algae
polychaete habitat	-	enhanced by geomorphic/flow stability, interruption of natural sediment supply, high nutrients and epiphytic algae	+	greater geomorphic/flow instability (including pulsed scour flows) and restoration of modest natural sediment inputs and eventual reduction in nutrients and epiphytic algae
myxospore production	-	adults highly infected producing large numbers of myxospores; compounding negative effect	+	reduction in myxospore output due to lower actinospore numbers from reduced numbers of polychaetes; compounding beneficial effect
myxospore distribution	-	spawned out adults concentrated near Iron Gate Dam and Hatchery, myxospores wash down into highest polychaete densities	+	spawned out fish distributed more evenly and not as well matched with high polychaete densities, hatchery production release points will change and disperse
adult salmonid mortality	-	higher risk of pre-spawn mortalities because of elevated levels of infection, which also increases myxospore output	+	lower risk of pre-spawn mortality and reduced myxospore output
juvenile salmonid mortality	-	unacceptably high mortality levels due to overwhelming numbers of actinospores, infected juveniles release myxospores which contribute to adult re-infections	+	decreased mortality levels as actinospore numbers fall below natural resistance thresholds, less myxospore output from infected juveniles
actinospore production	-	extremely high on average due to high polychaete numbers and elevated infection rates; compounding negative effect on myxospore levels	+	reduced due to lower polychaete numbers, decreased and dispersed myxospore production; compounding beneficial effect on myxospore levels
actinospore distribution	-	highest at top of anadromous distribution with actinospores washed downstream maximizing exposure to juveniles from upstream production areas	+	dispersed and not concentrated at top fish production areas; UKL serves as sink


CFS vs Histo
Histo
CFS
100
90
80
70
60
50
40
30
20
10
0
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2000
0
CFS
Jan-00 Jul-00 Feb-01 Aug-01 Mar-02 Sep-02 Apr-03 Nov-03 May-04 Dec-04 Jun-05 Jan-06 Jul-06 Feb-07 Sep-07 Mar-08 Oct-08 Apr-09 Nov-09
Date

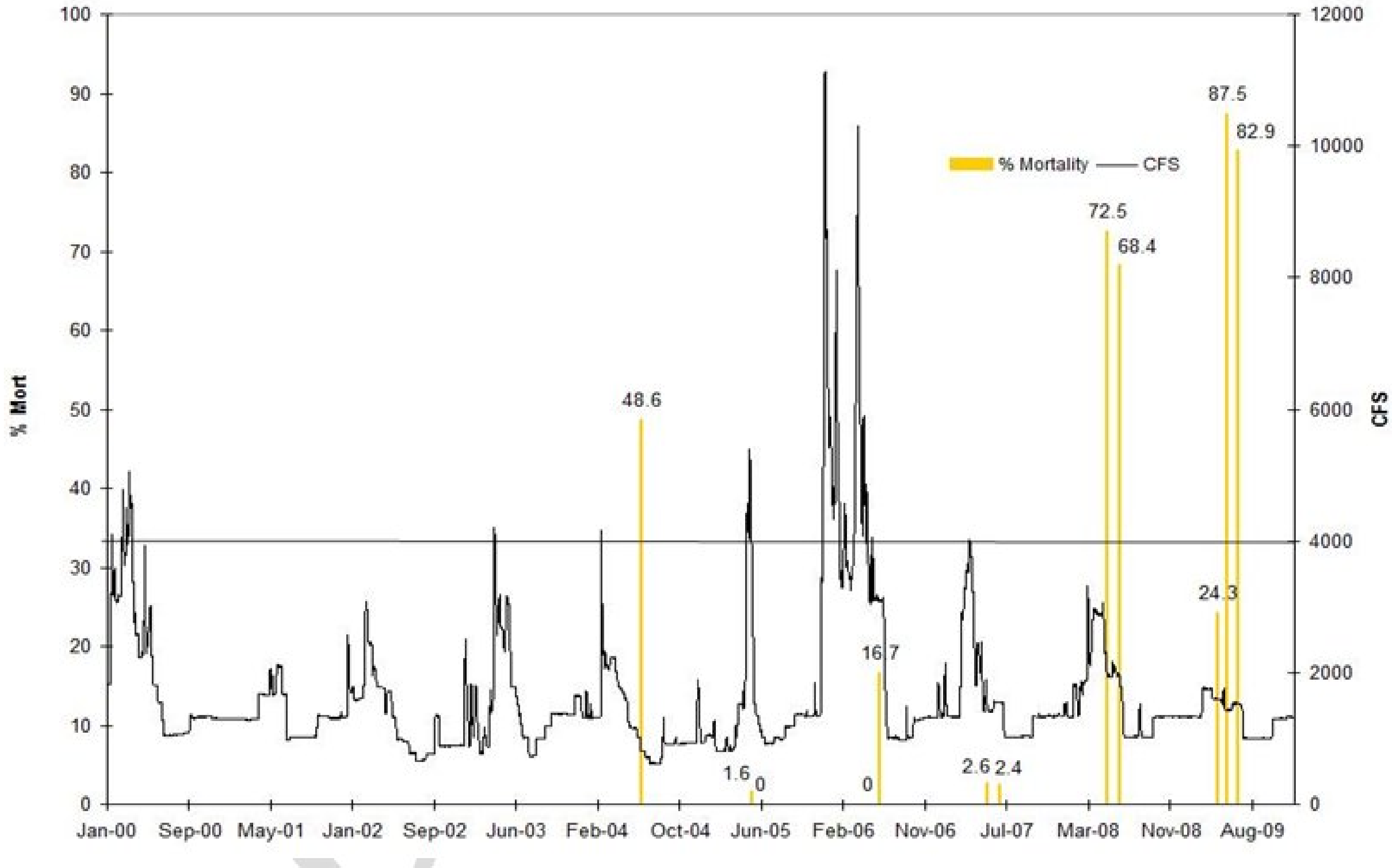
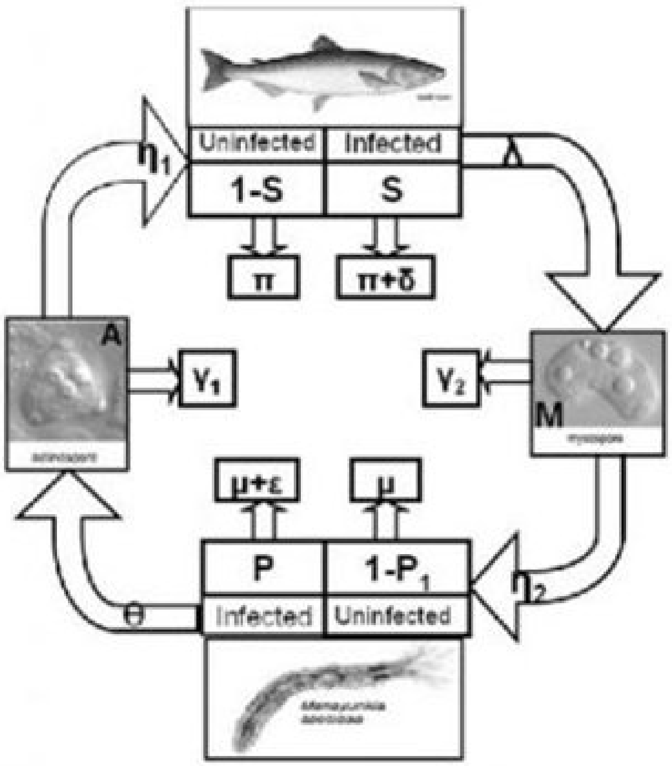


Figure 1. Graphs showing the decreases in ceratomyxosis in juvenile Chinook salmon following the flood event in the winter of 2005-2006 with a subsequent steady increase after with no flooding. Top graph is for fish captured in the mainstem Klamath River examined with histology while lower graphs shows sentinel exposures near Beaver Creek in the May and June primarily. Copied from Bartholomew and Foott 2010.



Symbol	Parameter
P	Proportion of infected polychaete
S	Proportion of infected salmon
A	Number of Actinospores
M	Number of Myxospores
η_1	Transmission rate to worm
η_2	Transmission rate to salmon
λ	Myxospore production
□	Actinospore production
π	Natural mortality of salmon
δ	Parasite induced mortality
μ	Natural mortality of polychaete
ε	Parasite induced mortality
γ_1	Loss of Myxospores
γ_2	Loss of Actinospores

Figure 2. Schematic of quantitative, epidemiology model of C. Shasta for the Klamath river under development by Adam Ray of OSU.

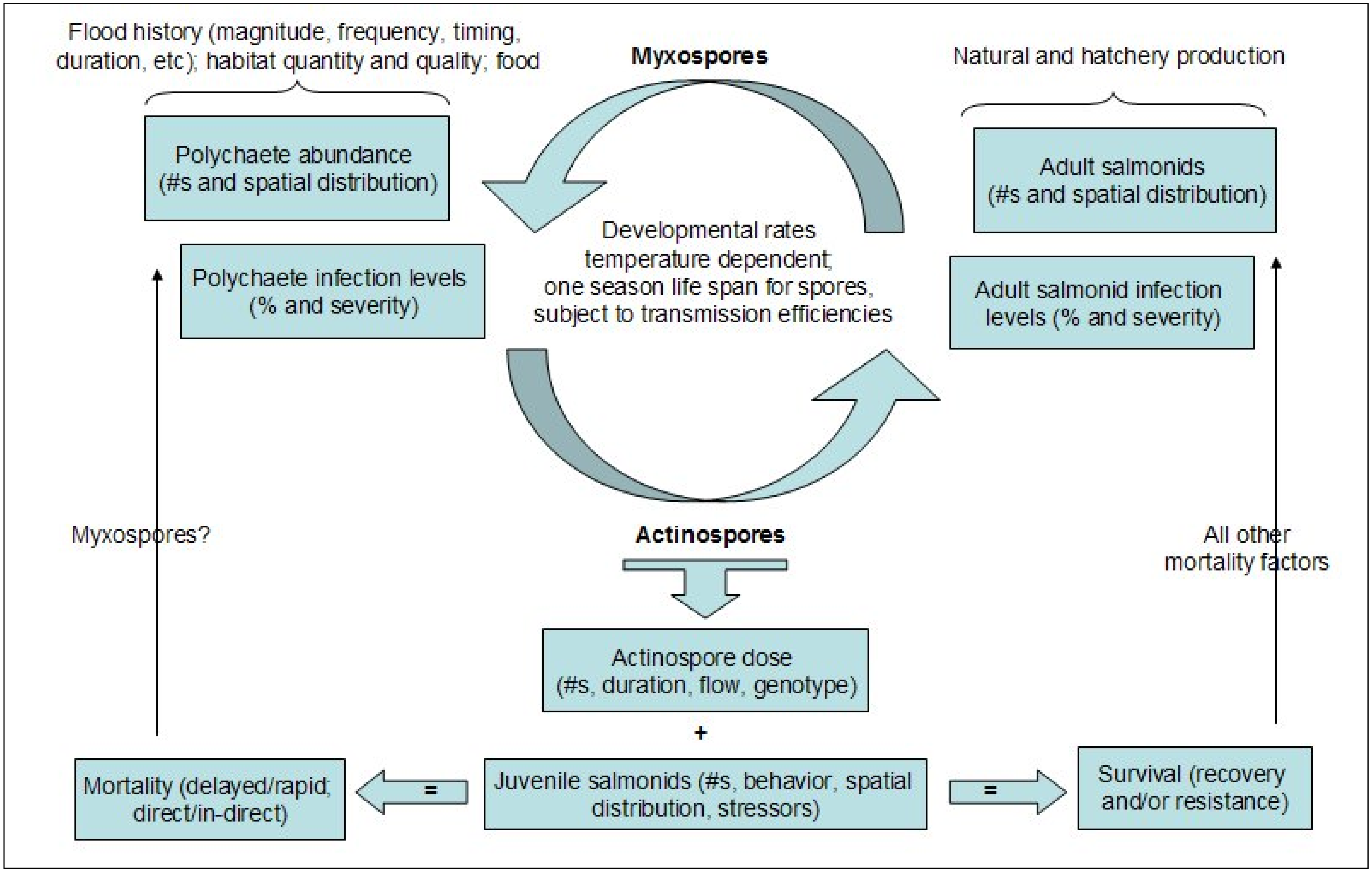


Figure 3. A working conceptual model of C. Shasta in the Klamath River allowing an evaluation of various hypotheses.

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