University of California Peer Review of:

BIOLOGICAL/CONFERENCE OPINION REGARDING THE EFFECTS OF OPERATION OF THE BUREAU OF RECLAMATION'S KLAMATH PROJECT ON THE ENDANGERED LOST RIVER SUCKER (Deltistes laxatus) ENDANGERED SHORTNOSE SUCKER (Chasmistes brevirostris) THREATENED BALD EAGLE (Haliaeetus leucocephalus) AND PROPOSED CRITICAL HABITAT FOR THE LOST RIVER/SHORTNOSE SUCKERS

As prepared by Klamath Falls Fish and Wildlife Office, April 2001

In August 2001 four University of California faculty members representing fields appropriate to address the scientific merit of the U.S. Fish and Wildlife Service Biological Opinion related to operation of the Bureau of Reclamation Klamath Project independently reviewed this Opinion. This summary represents the major findings of their review. The complete reviews are attached to this report.

The Biological Opinion provides a foundation for decision making to protect the endangered Lost River and Shortnose suckers. It makes recommendations regarding water quality and quantity, management strategies, fish entrainment, and fish passage. It is clear that more study and resources need to be focused on the Klamath Basin as an ecosystem including interactions and relationships between biotic and abiotic factors, and the species of concern. Such studies would provide better estimates and trends of organismal distribution and abundance and a better understanding of these species' biological performance in various habitat settings. If done, these studies would identify and support appropriate corrective actions to ensure that the endangered suckers survive.

The Biological Opinion uses lake levels in Upper Klamath Lake and the project in general as the key management decision to protect the endangered suckers. This is done based on the assumption that higher lake levels will improve water quality and provide better sucker habitat. Data to support specific water levels in Upper Klamath Lake and in other components of the project, and their relationship to long-term survival of the suckers are limited and in some cases not available. The ecological responses of affected species to changes in environmental conditions, notably hydrological and climatological, are complex and also suffer from an incomplete understanding of the ecology of the Klamath Basin. While lake level is important for survival of these species, there is weak evidence that lake level alone is a strong predictor of long-term survival of these two species. The reviewers are in general agreement that higher lake levels need to be maintained, but there is concern that maintaining higher lake levels will not significantly improve water quality because of the nutritional loading from runoff in the Klamath Basin, and that the improved water quality may still not result in increased survival of the sucker populations.

Water quality deterioration is the most immediate threat to survival and propagation of suckers in reservoirs and canals of the Project. While the survival limits of various water quality conditions are known, little information is available on the sublethal effects of these factors. We also know little about the complex interactions of water quality and other environmental factors and their impacts on the endangered suckers. The influence of project operation on water quality is not well developed in the Biological Opinion, and field data are apparently insufficient to make this connection. While the Biological Opinion recommendations are made to improve water quality, the degree of improvement and the resulting impact on the endangered suckers' long-term survival is unknown.

The Biological Opinion is generally supported by sound science and hard data, and appropriate literature and research sources are cited. Because much of the data are from unpublished reports it is difficult to adequately assess some of the interpretations made in the Biological Opinion. While this is a common situation in documents of this type, it should be recognized that many of the interpretations and assumptions in the Biological Opinion are not supported with data that have been evaluated or interpreted by the general scientific community. While this does not mean the Biological Opinion interpretations are invalid, it does call of restraint in using this material

In summary, the Klamath Basin suffers from water over-development and the recommendations for operation of project facilities are likely to conflict with reasonable demands for water for wildlife and agriculture. The Biological Opinion uses available data, some of it unpublished, which generally supports its recommendations. The recommendation to maintain higher lake levels is sound although this measure may not result in enhanced survival of the endangered suckers. Clearly much is unknown about the endangered suckers in the Klamath Basin and additional study is needed to better manage the Basin to ensure the long-term survival of the endangered Lost River and Shortnose Suckers, agriculture and wildlife in this important ecological region.

Review of

Biological/Conference Opinion regarding the effects of Operation of the Bureau of Reclamation's Klamath Project on the Endangered Lost River Sucker (*Deltistes luxatus*), Endangered Shortnose sucker (*Chasmistes brevirostris*), Threatened Bald Eagle (*Haliaeetus leucocephalus*) and Proposed Critical Habitat for the Lost River / Shortnose Sucker (as prepared by the Klamath Falls Fish and Wildlife Office, April 2001)

By

REVIEWER # 1

This Biological Opinion (BiOp) of the Fish and Wildlife Service is their response to the proposed action of the Bureau of Reclamation as it may affect the Klamath Project and the endangered sucker species (*Deltistes luxatus* and *Chasmistes brevirostris*) and the threatened bald eagle in the Klamath River Basin. The severe drought conditions in 2001 in this region have drawn national attention (e.g. feature story in *USA TODAY* 9 July 2001 and the *LOS ANGELES TIMES* 14 July 2001, and front-page news in the *LOS ANGELES TIMES* 23 July 2001).

The BiOp addresses the relationship between lake levels and water quality as is may affect the habitat for the fishes at various life stages and movements of adult fish. The conclusion (III.2.142-143) is that reduction in lake levels, as proposed by the Bureau of Reclamation, will have adverse affects on the fish populations that will include jeopardizing year-class development and the survival of all year classes of the suckers, and making them more vulnerable to disease and predators. The genetic consequences of population reduction (the bottleneck effect that reduces variation) are also noted.

I first read the BiOp <u>without</u> having read the accompanying reviews by the Oregon State University group and the Oregon Chapter of the American Fisheries Society. My overall impression was a positive one. The document does an excellent job of placing all information in a historical and geographic context for a complete understanding of the situation. This was a "quick read" after which I could recall some redundancy and a few problematic passages but no great problems with their argument. My charge to address two questions in particular follows:

Is the opinion based on sound science?

Reviewers of this kind of document often become frustrated at what has become a *modus operandi*. The vast majority of "Literature Cited" upon which the argument is based is not "literature" in the formal sense of published, peer-reviewed articles. Many of the articles are mere progress or interim reports, not even final reports. The science in these articles may or may not be sound. Conclusions therein may be preliminary. The

reviewers usually do not have access to these reports and are put in the position of having to give the authors of the BiOp the benefit of the doubt. Although some agencies require some kind of review (often non-anonymous) of final reports, these cited articles are considered to be "gray literature" by editors of major journals and unacceptable for citation. This criticism is not leveled at just this particular BiOp but to any such agency document that relies on reports and not on an anonymous peer review system followed by editorial input. However, I realize that the publication of articles often takes years and the need for this BiOp is immediate so one must make do with what information is at hand.

Are the interpretations of the scientific evidence justified?

If we accept the sources of information as sound, then the interpretations in this BiOp are justified. For example, Figure 1 (III.2.77) shows the relationships that influence fish condition and survival. Clearly, it is not just water level alone but other factors that combine to have adverse affect on the fishes. Thus, holding the FWS to justify a particular lake level makes little sense. The BiOp makes the case for negative impacts on the fish populations when the water is low under certain conditions. The implication is that these negatives are unlikely when the water level is high but possible when the water is low. The BiOp is worded carefully to protect the credibility of the Fish and Wildlife Service if indeed the lake levels are reduced and their concerns are not borne out. Nevertheless their concerns for the long-term recovery of these endangered fishes are legitimate. The continued operation of the Klamath Project must be modified to achieve the goal of recovery of these endangered fishes.

Overall evaluation of the opinion:

Without taking the BiOp to task for individual cases in which opinions may vary, my overall opinion remains a positive one. The BiOp has identified numerous problems with the recovery of the endangered Klamath Basin suckers and has outlined alternatives to consider. It is my personal opinion that the current situation is not one of jeopardizing the suckers to the point of risking immediate extinction. Rather these endangered species will risk reduction in numbers due to management decisions. Such reduction is at odds with recovery plans and reduction in genetic diversity may put these species at risk at a later date.

Additional comments:

I was also asked whether I concurred with the Oregon State peer review (and Oregon AFS review) of the BiOp. I read the reviews after reading the BiOp and was surprised at the negativity of their evaluations. It seemed like we were reviewing different documents. As it turns out, we were. Therefore, my own evaluation of the BiOp is brief and positive.

REVIEWER # 2

As you requested in your letter of 6-21-01, I have read the Biological Opinion (BO) prepared by the U.S. Fish and Wildlife Service on the operations of the U.S. Bureau of Reclamation's (USBR's) Klamath Project and its effect on the endangered suckers and on the threatened bald eagle. The following in my review:

Overall, I thought that the BO was quite complete, regarding the subjects covered, but that it was redundant in many respects, which added to its length. The first sections of the BO provide a history of previous BO requirements being incorporated into the current BO and a description of the action proposed by the USBR. The history of the area shows that much of the original streams, lakes, and surrounding wetlands habitat were greatly modified by early (non-sustainable) forestry practices; dams (for flood control, hydroelectric power, or agricultural water supplies; many of which are >50 years old); and dike-and-fill "reclamation" actions, primarily for agriculture. The effects of these actions (and subsequent problems, including erosion and resulting siltation of sucker spawning areas; introduction of nutrients from the soil or from fertilizers, resulting in hypereutrophication of some of the lakes; and the introduction of agricultural chemicals that are known toxicants to non-target organisms) are well documented throughout the BO. The importance of maintaining minimal lake levels during specific months, in years of different precipitation accumulation, is emphasized. The argument is made that these lake levels ensure sufficient volumetric dilution of nutrients and chemicals, sufficient cover depth of sucker spawning and rearing areas, and sufficient dissolved oxygen for the winter survival of suckers when ice blocks equilibration with atmospheric air and subsequent wind mixing and snow on the ice blocks light for photosynthetic production of oxygen. Although lake level may be a cost-effective way to estimate "environmental quality" for the two endangered sucker species, it is not a substitute for a more complete understanding of the system and its biota. Curiously, the quantity of water removed from the system, via diversions (e.g., for agricultural or municipal

uses), has, apparently, not been carefully quantified. With all the competing uses for high-quality water in this basin, these diverted amounts (and the agricultural return flows) should be quantified with sufficient accuracy in the future to better understand the Basin's overall water balance. For example, these data will be necessary to construct usable water models for future decision making when specific water-related actions are considered (e.g., removal of an existing dam, restoration of previous wetlands) or when insufficient precipitation produces a regional drought condition. The USBR's Drought Plan for the Upper Klamath Watershed of 2-12-92 (included in the BO) makes no mention of instream water requirements in the Basin.

The next section of the BO concerns effects on the endangered Lost River sucker, the endangered shortnose sucker, and the proposed critical habitat for the suckers. Besides the specific water depth-related cover and water quality-related problems for the suckers mentioned above, four other significant problems are mentioned. The first problem concerns (other) water quality effects on the suckers. The two species' absolute tolerance (survival limits) of low dissolved oxygen, high dissolved ammonia, and high water pH are known and cited. However, there are few studies on sublethal stress effects of less extreme conditions that may affect sucker growth rates, reproductive potentials, or resistance to pathogenic organisms. The second problem concerns sucker entrainment into unscreened diversions. Studies are needed to quantify sucker loss through gravity-fed and pumped diversions. If these losses are significant, at least pilot-scale studies should be conducted to determine if existing fish screen approach and sweeping velocity criteria for Klamath Basin diversions are appropriate for screening these two species. The third problem is the profound inability of suckers to use existing fish ladders (where ladders are present) at dams. Thus, an obvious need is for studies of fish passage facilities (i.e., by collaborating biologists and engineers) to effectively move migrating suckers (and other native fishes) past dams. Finally, the introduction of exotic species may have exacerbated recent sucker populational declines. The fathead minnow and the yellow perch introductions appear to represent significant predation pressure on young sucker life history stages. Further studies of these potential interactions are an obvious need.

Overall, the BO makes many statements that are backed up by references (either peer-reviewed publications, reports, or student theses). Unless one has access to these references, it is difficult to state whether the statements or conclusions made in the BO from these references are interpreted "correctly," either as the original author(s) intended or as improved via an alternative analysis. Usually, the peer-review process provides a "filter" that reliably assures that the data have been appropriately collected and analyzed, the arguments are logically constructed, and the conclusions are sound. However, the peer review process is not perfect, and one can find examples of inappropriate analyses, for example, in journal articles. However, these examples are few, and there are many more examples of scientifically sound studies have not been published in peer-reviewed journals. Obviously, the much more limited distribution of unpublished reports makes them comparatively unavailable for examination. The reasons for not publishing good studies are many, but too often agency biologists are not provided adequate time or financial rewards for publishing their results. The unpublished reports and thesis that I did check (Buettner and Scoppettone 1991, Scoppetone, Shea, and Buettner 1995, Perkins and Scoppettone

1996, and Martin 1997) impressed me as good studies and the results appeared to have been interpreted correctly in the BO. In many cases where the BO does not provide hard evidence for a statement (e.g., middle of page 136 of Section III, Part 2, concerning the amount of water removed from the system before it reaches Upper Klamath Lake), at least supporting information is provided to provide an estimate. Usually, these "omissions" appear to stem from a lack of sufficient information. Overall, the intent of the BO's authors appears to be to protect living resources estimated to exist at population sizes that are a small fraction of their previous abundance. Despite some typographical, formatting, and spelling errors found throughout the text, the BO does not appear to be intentionally incomplete or misleading (including any misinterpretation of available data). Thus, any claim of the BO espousing "unsound science," must be tempered with the fact that we know so little about these fish: their distribution and abundance in the various rivers, lakes, and reservoirs; their interactions with other species; and their sublethal responses to environmental changes. It is obvious to me that more, good scientific studies are needed in this system. Adequate resources (including personnel) should be devoted to a better understanding of the native fishes (of the entire watershed) and their requirements. The coho salmon in the system has been granted some protections under the Endangered Species Act, and a petition has been recently filed for the green sturgeon's protection under the same Act. These protections, along with those covered in the BO, strongly signal that our natural heritage is slipping away towards extinction and that drastic measures may be needed to reverse these trends.

One area that should be examined is agriculture in the Upper Klamath Basin. The farming practices in the Basin need to reduce nutrient inputs to the watershed. A recent article by Kafka, Kirby, and Peterson (2001, California Agriculture 55(3):42-47) described how fertilizer application reductions in farming sugarbeets can protect water quality in the Upper Klamath Basin. This crop showed no increased root or recoverable sugar yields when either nitrogen or phosphorus fertilizers were applied. Crops like sugarbeets actually remove 20-30 pounds of phosphorus and 120-150 pounds of nitrogen per acre (Kafka and Hills 1994, Encyclopedia of Agricultural Science 4:215-223), minimizing late growing season leaching of soluble nutrients into surface waters (Kafka et al. 2001). Thus, sugarbeet production with limited fertilizer application, when this crop is harvested and transported to markets, minimizes agriculture-related nutrient inputs to the watershed and consequent hypereutrophication impacts on the fishes. The reconversion of farmland back to wetlands (especially along the margins of the lakes, as described in the BO) is another important step in providing "ecological services" for the system. Such services would include clean water for endangered suckers, coho salmon, and green sturgeon, and habitat for eagles and the waterfowl upon which they depend for prey. These positive steps will assist in the recovery of our endangered fishes.

In conclusion, the BO provides a good start on sound decision making to ensure that our natural heritage does not slip away into extinction. The BO makes good recommendations regarding water quality, fish entrainment, and fish passage concerns. It is clear to me that much more study and more resources need to be focused on the Basin, as an ecosystem. Such studies and resources would provide better estimates and trends of organismal distribution and abundance and a better understanding of these species' biological performance in various habitat settings. These

studies would point out appropriate corrective actions to be taken to ensure that unique species, which are such an important part of the indigenous peoples' cultural heritage, do not disappear.

Review

BIOLOGICAL/CONFERENCE OPINION
REGARDING THE EFFECT OF OPERATION OF THE BUREAU OF RECLAMATION
KLAMATH PROJECT ON ENDANGERED AND THREATENED SPECIES

by

REVIEWER # 3

BACKGROUND

This review addresses the adequacy of a Fish and Wildlife Biological Opinion (BO) issued April 15, 2001, that in turn responded to a biological assessment (BA) by the *Bureau of Reclamation designed to ensure* operation of the Klamath Project in a manner that does not jeopardize continued existence of endangered and threatened species or that might modify their critical habitat. It is recognized at the outset that this BO addresses in detail the characteristic life cycles of the several endangered or threatened species of "suckers" and also that of the bald eagle with which the reviewer is only casually informed. Therefore, no attempt is made here to reexamine or additionally critique specific biological issues. Rather, particular attention is directed in this review to the possible effects of project operation on hydrologic balances of water resources within the basin, the maintenance of water levels and flows, water quality, and ecological consequences of changes proposed in the BA that may not have been fully assess in the BO, detailed as it is.

1. Hydrological Factors

1.1 Project Situation The Klamath Project, situated in southern Oregon and northern California, has been from the outset of its creation a stressed environment. It has not enjoyed the usual natural benefits of semi-mountainous terrain: rechargeable ground water reservoirs, perennial surface runoff, capacity for snow storage, and higher than average annual precipitation. Evaporation and evapo-transpiration rates *are high for what vegetal cover there is. 150 years of agricultural development,* including 220,000 acres of irrigated project lands receiving water from three main reservoirs with a total surface area of 100,000 acres, has resulted in utilization of virtually all of the available water resource. A prime wild fowl habitat originally centered on Tule and Lower Klamath lakes has diminished to the point where these *surface water resources serve primarily as terminal drainage sumps. The Upper* Klamath Basin is clearly an environment where water demands frequently exceed the available supply. Recent experience attest to a hydrological imbalance exacerbated by agricultural development beyond prudent levels.

1.2 Project Vulnerability Faced with increasing demands for water over the years of project operation, the Klamath Project has been forced to adjust its priorities and constrain its operation to meet the combined exigencies of agriculture and wildlife preservation. Both are destined to "take a hit", as it were, by accepting less than a full cup. The primary problem facing water managers of the Project is to allocate fairly and "optimally" an increasingly limited water resource. This has to be done in the face of needs for the preservation of endangered and threatened species.

1.3 Operation Targets As this reviewer sees it, the USBR has developed a set of target water levels in its main supply reservoirs that it asserts will maintain current average levels of supply. The problem the USBR faces is that demands on a limited resource have trended upwards in the past several decades while the available resource, subject to the uncertainties in natural systems, has trended downwards. Both the BA and the BO acknowledge that the coming year is likely to the driest on record. This will place maximum stress on the Klamath ecosystem which is affected by lower than normal water levels. (Note: This stressful situation has already, as this review is being prepared, prompted deliberate actions by some individuals to violate protocols of operation proposed by Project operators.) It is clear from the factual evidence of historic runoff and current climatological conditions that expectations for a balanced hydrological system are at near historic minimums.

1.4 Hydrological Time Series Ecological impacts of Project operation are directly keyed to the hydrologic conditions of the Upper Klamath Basin. To provide a quantitative basis for assessing potential ecological impacts Reclamation has analyzed data on historic operation of the principal reservoirs it manages (Upper Klamath Lake, Gerber and Clear Lake Reservoirs). Using the water accounting model KPOPSIM and 38-year historic records of inflows, it has projected probable water levels for each of four hydrologic year types: above normal, below normal, dry and critical. This reviewer concurs in the Service's assertion that the time series of inflow to project reservoirs is too short for reliable statistical analysis, particularly with respect to extreme drought events. Data on inflows are not normally distributed statistically, so inferences based on averages are likely to be misleading. A long-term time series (60-100 years) of inflows would very likely be skewed toward drought events, which if true would attest to the vulnerability of the system to imposed stresses on the ecosystem. This reviewer concurs in the contention that future droughts are likely to be longer, more frequent and more severe. The prospect of global climate change, although uncertain as well, also signals caution in extrapolationg recent trends in project inflow into the future.

2. Maintenance of Water Levels

2.1 Estimating Project Performance Project operators have the capability to store natural runoff from the tributary watersheds and to regulate releases to other project components, thus determining water levels and changes in storage. Reclamation has developed a computer spread sheet model KPOPSIM that "simulates" project operation given a specific set of inflows and the present state of the system. The model operates on monthly averages of flows and water levels, guided by operating rules that set target flows and elevations for system components. Typically, the model produces a set of water levels in the various storage components that would result from setting monthly mean inflows or outflows at the boundaries of the modeled domain with adjustments for evaporation, precipitation, local exports and other losses. Alternative operation scenarios may be examined for their effects given time series of average inflows for above normal, below normal, dry and critical year types. The model provides guidance concerning the possible effects of changes in flows, water levels, and storage volumes. It is a "tool" to aid operators in meeting specific project objectives, but for the reasons noted above model predictions, especially those for dry and critical years, are likely to be unreliable.

2.2 Impacts on ecosystems Future drought scenarios will surely be characterized by lower water depths in most reservoirs, elevated temperatures, critically low dissolved oxygen concentrations, and loss of critical habitat and spawning areas. Exposure of shallows to erosion by lowering water levels and sediment deposition in the deeper channels of tributaries will likely reduce spawning and rearing habitat. It appears likely that proposed low lake levels will be difficult to achieve with reasonable certainty. The prospect of more frequent fish kills, although difficult to predict and quantify, seems very likely.

3. Water Quality

The BO indicates that the "greatest and most immediate threat (to suckers) posed by the proposed action is the potential exacerbation of already poor water quality conditions in UKL." This reviewer concurs in these conclusions with the following observations.

3.1 Temperature Effects Water quality conditions in the Project are closely linked to hydrological and climatological conditions. Increased insolation, reduced cloud cover, increased air temperature and reduced relative humidity associated with severe droughts may be expected to elevate water temperatures to levels adverse to sucker survival. Elevated water temperatures will, in turn, accelerate biological processes, e.g., respiration, biodegradation, decomposition, photosynthesis, etc., and increase primary production of aquatic vegetation. Combinations of these processes, coupled with diminished water depths in the shallow margins of the impoundments threaten the survival of sucker species in these locations. As lake levels decrease and water temperatures rise *AFA* production may be expected to increase with negative consequences to water quality. Water temperatures may be expected to exceed 35 degree C during summer months in many parts of the system where *AFA* production rates are highest

3.2 Dissolved Oxygen Depletion of dissolved oxygen in shallow waters by these processes, although partially offset by reaeration by hydromechanical mixing and diffusive mass transfer of oxygen from the atmosphere, is probably the most important negative effect on sucker survival. DO concentrations below 2 mg/l, the approximate threshold for survival, are likely to persist along the margins of impoundments throughout the project area. That such conditions exist appears to be well documented in the BO, but actual data are rather sparse. That future conditions of project operation are likely to increase the likelihood of DO concentrations below critical survival levels in many areas of the Project appears a certainty. However, it seems likely that such events will not be so severe as to decimate sucker populations beyond recovery levels.

3.3 pH Increased production of algae, *AFA*, and other aquatic vegetation along the lake margins may be expected to increase pH levels, possibly above about 9.5, a level that may be inimical to fish. In drought years there would be a high expectation of such conditions, that when coupled with low DO (<4 mg/l), and high temperatures (>35 degrees C) would severely stress extant populations of suckers, especially in the shallower sections of the lakes.

3.4 Benthos Primary productivity in shallower areas of the lakes would be expected to result in deposition of organic detritus, contributing to benthic oxygen demand, and additional load on overlying dissolved oxygen resources.

4. Management Strategies.

A second important factor in sucker survival is the limitation imposed on available spawning and rearing habitat as a result of reduced depths caused by water withdrawals. Pertinent observations are as follows.

4.1 Maintenance of Lake Levels Both Reclamation and the Service agree that maintenance of highest possible lake levels in UKL is the only feasible means of reducing "AFA productivity and associated stressful and/or lethal summertime water quality." Hypereutrophic conditions in the UKL are the result of accelerated nutrient loadings over the past century. It is unlikely that the present conditions can be significantly changed due to operational changes that focus only on lake levels, but this may be the only practical short term remedy for alleviating DO depressions.

4.2 Spawning Depths Maintenance of water depths greater than 2 feet may be critical to sucker spawning success. This goal may be difficult to meet as has been demonstrated in modeling studies by Reclamation. Increasing lake levels reduces the photic zone, thereby reducing AFA productivity and relieving DO stresses. In contrast, decreasing water levels increases temperatures and stimulates algal growth in the shallow areas available for spawning.

4.3 Year Class Development Both the Service and Reclamation agree that the proposed action would adversely affect year class success and survival.

4.4 Critical Habitat Reclamation and the Service disagree on adverse effects on critical habitat. Reclamation asserts that the proposed action would not likely adversely affect proposed critical habitat. The Service disagrees. This reviewer takes the side of the Service primarily on the basis of the severity of water quality deterioration , but also in recognition of the highly probable exacerbation of water quality related stresses due to extreme hydrological and climatological conditions.

5. Summary and Conclusions

This review of the Service's Biological Opinion has been focused on four major topics: hydrology, water levels, water quality, and water management as they relate to the fate of threatened or endangered aquatic species in the Upper Klamath Basin under conditions of an action plan proposed by Reclamation.

While the BO is extremely detailed and excessively wordy, it provides a good account of the existing biological situation. It is generally supported by sound science and hard data. Appropriate literature and research sources are cited. The opinion clearly reflects the Service's bias toward its mission. Recommendations for operation of project facilities are offered that are likely to conflict with reasonable demands for water supply for irrigated agriculture, although they may well conform with the Service's charge. The Service's declaration that the comparatively short time series (38 years) used by Reclamation is insufficient for statistical analysis is arguably correct. Reclamation's simplified statistical treatment of historical inflow data

supports this conclusion. It may be that review of KPOPSIM simulations would reveal a more thorough investigation of project operating statistics. In any event more attention and weight should be placed on extreme events in statistical analysis of hydrological data.

It is clear from the information provided in the BO and Reclamation's plan that the Upper Klamath Basin is an extremely stressed environment. Limited water supplies have been over-developed, largely for agriculture, to a point where demands frequently exceed supplies. The most serious consequence of the imbalance between supply and demand has been a progressive deterioration of water quality. Low water levels, elevated water temperatures, and low dissolved oxygen concentrations combine to threaten the viability of various species of suckers inhabiting project reservoirs and water conveyance facilities.

The influence of project operation on water quality is not well developed in either the BO or by Reclamation. Field data are apparently insufficient to make this connection. Water quality deterioration is evidently the most immediate threat to survival and propagation of suckers in reservoirs and canals of the Project. A more up to date modeling effort to characterize water quality in the Klamath Project is recommended.

Overall, the Biological Opinion of the Fish and Wildlife Service represents a conscientious effort to address the important issues confronting aquatic species likely to be affected by Reclamation's proposed operation plan. It is a valuable resource for all who are interested in the future of water resources, development, utilization and planning in the Upper Klamath Basin.

REVIEWER # 4

This evaluation examines the report: Biological/Conference Opinion Regarding the Effects of Operation of the Bureau of Reclamation's Klamath Project on the Endangered Lost River Sucker (*Delitstes brevirostris*), Endangered Shortnose Sucker (*Chasmistes brevirostris*), Threatened Bald Eagle (*Haliaeetus leucocephalus*), and Proposed Critical Habitat for the Lost River/Shortnose Suckers, prepared by the Klamath Falls Fish and Wildlife Office, April 2001.

I evaluate this document from the aquatic ecology viewpoint to determine whether the above opinion, and especially the conclusions reached, are based on established scientific principles as applied to lake ecology and fish biology. Please note that I am not commenting on the effects of proposed activities on the anadromous salmon populations, which will undoubtedly be affected by the proposed activities that may reduce river discharge. An evaluation of this report is difficult to complete because: (1) A document of this length, written with input from several sources and contributors, contains much extraneous information that is not pertinent to the ultimate management question being addressed; this required sifting through scores of pages and deciding what information is relevant to the issue. (2) Because many of the relevant conclusions are based on interpretation of data that are sequestered in unpublished studies and reports, evaluation is often problematic. This is especially so, given that the team of Oregon State University scientists who are very familiar with the biology of the two sucker species in question, charge that misinterpretations (and in some cases perhaps misrepresentation because some of the conflicting data is not considered in reaching conclusions in this opinion) occur in the report. Therefore, the mixture of relevant and ancillary information, my inability to obtain and examine the results of the studies on which conclusions are being based, and the fact that the Oregon State University scientists most familiar with the problems in the Klamath Project question interpretations makes my charge more difficult.

The two species of sucker under threat from these activities are both long-lived highly fecund species. Suckers in general originally evolved from minnow-like ancestors in Asia (where they have nearly died out.) In North America, the suckers that have prospered perfected their bottom-browsing way of life through microevolutionary processes from the original, native suckers in California. Unfortunately, the majority of these aforementioned,

previously successful species, are rare, threatened, or endangered. That both the populations of the Lost River Sucker and the Shortnose Sucker are in peril is not in question; it is whether the proposed actions are justified based on existing scientific information. Clearly, these long-lived species need periodic annual recruitment and certain age structures to be present in their population for their long-term survival.

The Biological Opinion, in attempting to create management decision rules, is using lake levels in Upper Klamath Lake essentially as the surrogate of survival for the two species of suckers in question. The Oregon State University report rightly concludes that correlation analysis is problematic because over an annual cycle lake direction proceeds in one direction; it always decreases. Consequently, some apparent relationships are present as a result of temporal covariates and not necessarily as statistical correlates.

In the Executive Summary of this Biological Opinion (p.ii), the report concludes that at Upper Klamath Lake, "implementation of the action, as proposed, is likely to have the following effects on the suckers and their proposed critical habitat." A list of seven points are then presented. This is followed by three points regarding Clear Lake, Gerber Reservoir, and the Tule Lake swamp. From reading (and rereading) this report it is apparent to me that all of these 10 points could occur and several are likely to occur. However, the choice of one variable, lake level, as the predictor that all of these events are likely to occur is, in my opinion, not based on sound science. The survival of these two species of sucker involves complex interactions involving not just the amount of water and the quality of the water, but also effects of other abiotic factors on the two populations, and on biotic interactions involving predators, alternative prey, food items, and a myriad of other factors that have not been investigated. Simply put, there is weak evidence, in my opinion, that lake level alone is a strong predictor of long-term survival of these populations. Again, please note that the above statement does not rule out that the deleterious 10 effects described in the report may in fact occur; but I question whether assuming that lake level alone can be used as the determiner that these events will or will not occur is not justified.

In the Oregon State University response, they describe numerous situations where lowered lake elevations did not worsen water quality and resulted in kills of suckers (e.g. the two lowest water years 1992 and especially 1994). They conclude, and from my experience I agree, that water quality decreases can result from a variety of factors that can function independently of lake level. Certainly, there is a situation in which water level (again or perhaps an abiotic or biotic covariate) becomes so low that survival of these species is imperiled. To me, though, they have not provided convincing evidence that 4139-4140 ft. is that level.

Furthermore, the inappropriate or incorrect interpretations of sucker die off (p. 67), predation on suckers (p. 94), immigration (p. 127), substratum type and lake elevation effects (p. 20), and many other conclusions in the report, which were highlighted by the Oregon State University biologists in their critique, make me uncomfortable in unequivocally accepting the conclusions and recommendations of this report.

REVIEWER # 4

In conclusion, I understand that the management agencies want a simple measure for decisions. In essence, using the water level of Upper Klamath Lake is like using a thermometer to assess human health. We are sure that some relationship between human health and body temperature exists, and that there are certain temperatures (e.g. in excess of 106 F) at which survival does not continue (which is analogous to the lake going dry). But what about temperatures in between normal and lethal, or sub-normal temperatures (e.g. analogous to poor water quality at high lake levels) that also indicate illness. Like the thermometer, changes in lake levels are not exactly calibrated with degrees of survival.

I will gladly provide elaboration of the above points or any additional information you may require. In essence, I accept the conclusions about the Biological Opinion . by the Oregon State University biologists.