United States Department of the Interior

FISH AND WILDLIFE SERVICE

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Memorandum April 25, 2002

To: Regional Director, Bureau of Reclamation
Sacramento, California

From: Manager, California/Nevada Operations Office
Sacramento, California

Subject: Biological Opinion on the 10-year Operation Plan for the Klamath Project

A draft of the subject opinion is attached for your review and comment in response to your February 25, 2002, request for formal consultation. At issue are the effects of operating the Klamath Project on the endangered Lost River sucker, endangered shortnose sucker, threatened bald eagle, and proposed critical habitat for the suckers. The draft opinion was prepared in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.).

The draft opinion fully considers the Bureau of Reclamation's biological assessment, dated February 25, 2002, and the findings contained in the National Academy of Science Interim Report from the Committee on Endangered and Threatened Fishes in the Klamath River Basin entitled *Scientific Evaluation of Biological Opinions on Endangered and Threatened Fishes in the Klamath River Basin.*

Although we recognize that substantive changes to operation of the project that will benefit the conservation of the Lost River and shortnose suckers are included in the proposed action, the draft opinion includes findings that the proposed action is likely to jeopardize the continued existence of both sucker species and result in the adverse modification of proposed critical habitat.

We reached the jeopardy conclusion based on the following anticipated effects of the proposed action on the reproduction and numbers of the Lost River and shortnose suckers at Upper Klamath Lake that are incompatible with the conservation (i.e., survival and recovery) needs of these species.

Sucker Entrainment at Project Dams and Diversions in Upper Klamath Lake

Project water diversions, including dams and hydropower diversions, in Upper Klamath Lake will entrain millions of larvae, tens of thousands of juveniles and possibly thousands of sub-adult and adult suckers. This entrainment substantially reduces sucker populations and limits the amount of recruitment into the adult spawning populations. The screening of A-Canal by 2003 will reduce entrainment losses of juvenile, sub-adult, and adult suckers. However, entrainment of larvae will be only minimally reduced. Entrainment of all sucker life stages will continue to occur at the Link River Dam. The number of suckers entrained at the Link River Dam through the diversions into the canals and into the Link River are likely to increase if suckers bypassed from the A-Canal move a short distance downstream to the Link River Dam. Suckers entrained past the dam will be trapped downstream in the Link River, Lake Ewauna and the Keno Impoundment. The proposed fish ladder at the Link River Dam should allow spawning adult suckers to return upstream past the dam, but the smaller juvenile and sub-adults will remain isolated downstream where their survival will be reduced by poor water quality.

Sucker entrainment of this magnitude will appreciably reduce recruitment of new age classes into the adult spawning population and increase the risk that future fish kills will further depress sucker populations.

Effects of Project Operations on Water Quality in Upper Klamath Lake

Proposed water management under the Project is likely to have substantial adverse effects on water quality and sucker health in Upper Klamath Lake under certain conditions. Shallow water depths during dry and critically dry inflow year types are likely to increase the frequency and magnitude of localized fish kills by increasing the number and extent of areas affected by pre-dawn DO declines during July-October. Use of the proposed 70% exceedance forecast to predict inflow year types underestimates inflow predictions in 7 out of 10 years, and will result in the management of Upper Klamath Lake for drier year types and lower lake levels with adverse effects on water quality and suckers more often than actual inflows would warrant.

The operation of Link River Dam is likely to periodically increase storage of nutrient-rich, spring storm inflows above the hydrologic baseline in Upper Klamath Lake. These additional nutrients are likely to increase summer algal biomass, which during bloom decline leads to adverse water quality, especially low DO levels, and can lead to catastrophic fish die-offs similar to those that resulted in the loss of an estimated 80-90% of the adult sucker population in Upper Klamath Lake during the 1990's under certain environmental conditions. Such events, although unpredictable in frequency, pose a major risk to survival and recovery of the Upper Klamath Lake sucker populations.

In summary, Project effects on Upper Klamath Lake water quality are likely to appreciably increase the risk of fish kills that will reduce the numbers of suckers in Upper Klamath Lake.

Sucker Habitat Loss in Upper Klamath Lake

The proposed action is likely to have significant adverse effects on sucker habitat in Upper Klamath Lake during some inflow year types:

The proposed lake levels reduce late summer/fall adult sucker habitat by as much as 50% in dry and critically dry years. This will exacerbate adult sucker habitat limitations caused by areas of adverse or lethal water quality during the summer and fall when lake levels and habitat availability are at their lowest.

During dry and critically dry inflow year types, shallow water depths in August-October reduce sucker access to water quality refuge areas in the northwest lobe of Upper Klamath Lake which is likely to result in higher adult sucker mortality during large-scale fish kills.

The proposed minimum lake levels during the critically dry inflow year type will substantially limit in-lake sucker spawning habitat and are likely to cause loss of sucker reproduction in those years.

During the period from August through October of below average, dry, and critically dry years there is likely to be a substantial loss of late-season juvenile sucker habitat and a high risk of year-class failure in critically dry years.

Although the proposed action will generally provide sufficient habitat for larval suckers in most inflow year types, there is a high risk of larval year-class failure for the Williamson River spawning population of suckers as a result of lake level management proposed for the critically dry inflow year type.

In summary, the magnitude of anticipated sucker habitat loss under certain conditions is likely to appreciably reduce the reproduction and numbers of suckers at Upper Klamath Lake.

Collectively, the significance of these adverse effects are magnified because of the depressed condition of the Upper Klamath Lake sucker population following three major fish kills during the 1990s that resulted in the loss of an estimated 80-90% of the adult sucker population in Upper Klamath Lake. Although there is evidence that over the last four years suckers in Upper Klamath Lake are slowly increasing in numbers, the rate of this increase is sufficiently slow that it will require several additional sub-adult cohorts entering the adult population to replace those adults that were lost. This is especially the case for the shortnose sucker, which has shown only a slight population increase since 1997. Although the number of adult suckers in Upper Klamath Lake may increase, the reproductive potential of newly recruited young spawners, until they have additional time to grow and mature, will not be equivalent to the larger older adults they replace. Available information indicates that only 2 or 3 significant recruitment events (sub-adults entering the adult spawning population) have occurred in the last 17 years. At this rate, it may be a decade or more before adult sucker population numbers and reproductive potential are as high as they were prior to the die-offs of the 1990s.

In order for the Upper Klamath Lake populations of the Lost River and shortnose suckers to persist in the currently hypereutrophic condition of the Upper Klamath Lake ecosystem, they must be able to successfully reproduce and recruit new spawners into the adult population to compensate for the recurring loss of mature individuals resulting primarily from fish kills. To do this requires reducing entrainment and the effects of adverse water quality on the suckers and their habitat. If the occurrence of major fish kills is more frequent than significant recruitment events, the populations of the Lost River and shortnose suckers will continue to decline.

The fate of sucker populations over the next 10 years and beyond will be determined by the balance between the frequency and magnitude of fish kills and entrainment, and the frequency and magnitude of recruitment to the adult spawning population. For the reasons listed above, the proposed action will adversely affect that balance to the degree that it constitutes an appreciable reduction in the likelihood of both the survival and recovery of the Lost River and shortnose suckers by substantially reducing their reproduction and numbers at Upper Klamath Lake under certain conditions. Therefore, the Service concludes that operation of the Klamath Project, as proposed, is likely to jeopardize the continued existence of the Lost River and shortnose suckers.

We reached the adverse modification of proposed critical habitat conclusion based on the following anticipated effects of the proposed action on the primary constituent elements of proposed critical habitat: (1) temporary reductions of water levels by water diversions that preclude sucker use of important seasonal habitats during critical periods of their life cycle; (2) reduction in water levels at the Tule lake Sump caused by increased sedimentation from agricultural practices; (3) temporary reductions of water quality that preclude sucker use of important seasonal habitats during critical periods of their life cycle; and (4) blockage of passage preventing suckers from using habitats necessary for completion of their life cycle.

In accordance with regulation, we have developed a reasonable and prudent alternative (RPA) that removes the jeopardizing effects of the proposed action in a manner that allows for irrigation deliveries to occur. A major component of the RPA involves the application of an adaptive management approach to implementing project operations at Upper Klamath Lake to address water quality, entrainment, and habitat effects in a manner that provides the Bureau of Reclamation management flexibility and recognizes the biological complexity of this important ecosystem.

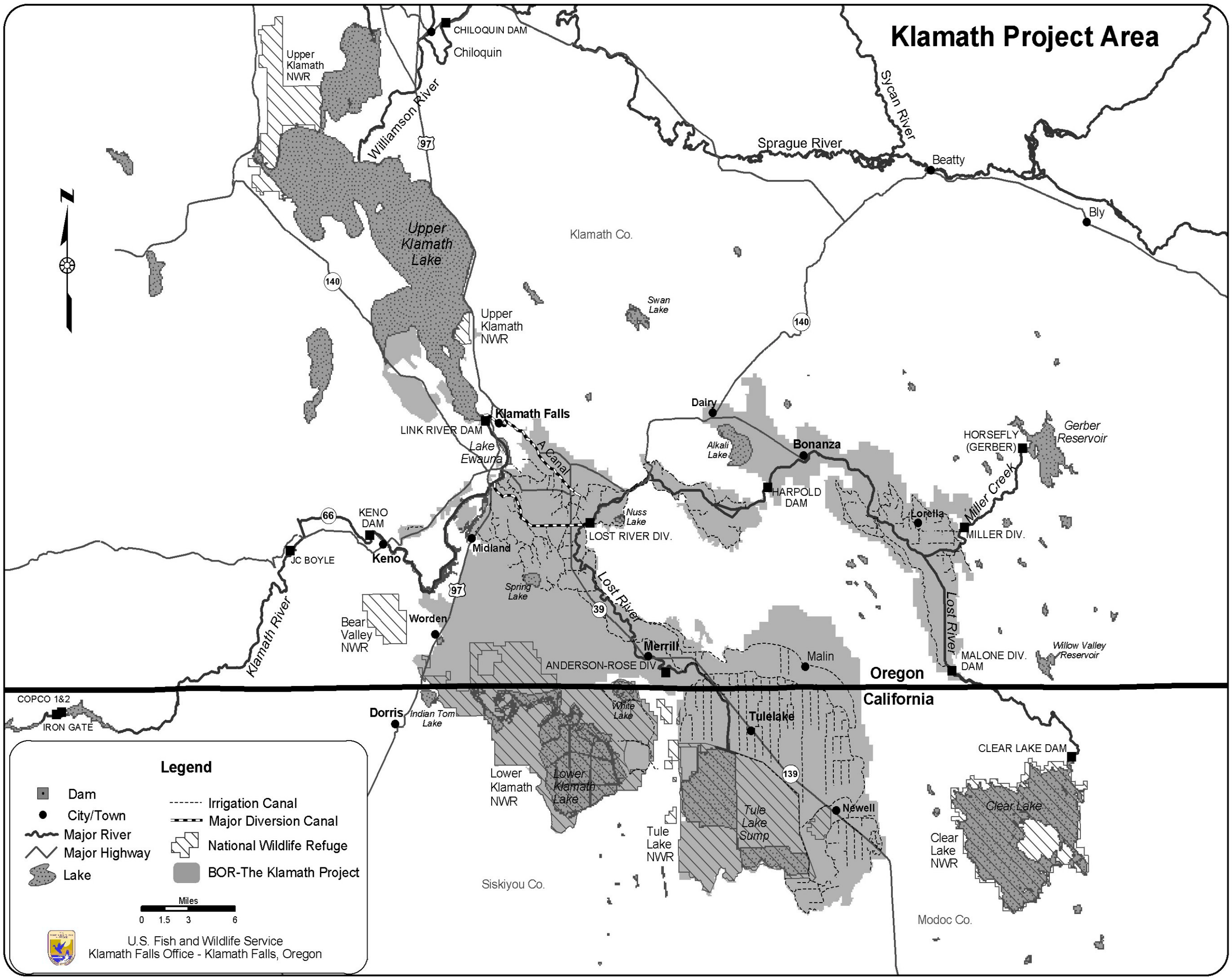
Although implementation of the RPA will also address most of the adverse modification effects to proposed sucker critical habitat, we need to further coordinate with you to completely address this issue. We recognize that our findings and recommendations relative to proposed sucker critical habitat are strictly advisory and are not binding. However, we believe it is in the best interest of both of our agencies to adequately address effects to proposed critical habitat prior to that proposal being finalized.

Please provide us with your written comments on the draft opinion by the close of business on May 10, 2002. Comments should be sent to Steve A. Lewis, Project Leader of our Klamath Falls Fish and Wildlife Office, 6610 Washburn Way, Klamath Falls, Oregon 97603. With your concurrence, we will also provide a copy of the draft opinion to the Klamath Tribes, Oregon Department of Fish and Wildlife, California Department of Fish and Game and relevant recognized experts for their peer review and comment. Please note that incorporation of the RPA by the Bureau of Reclamation into the proposed action will result in our issuance of a final no jeopardy biological opinion.

Attachment

DRAFT
BIOLOGICAL/CONFERENCE OPINION REGARDING THE EFFECTS OF OPERATION OF THE U.S. BUREAU OF RECLAMATION'S KLAMATH PROJECT ON THE ENDANGERED LOST RIVER SUCKER (Delistes luxatus) ENDANGERED SHORTNOSE SUCKER (Chasmistes brevirostris) THREATENED BALD EAGLE (Haliaeetus leucocephalus) AND PROPOSED CRITICAL HABITAT FOR THE LOST RIVER / SHORTNOSE SUCKERS FOR JUNE 1, 2002 - MARCH 31, 2012

Prepared by the
Klamath Falls Fish and Wildlife Office
Klamath Falls, Oregon


Klamath Project Area
CHILOQUIN DAM
Chiloquin
Upper Klamath NWR
Williamson River
Sycan River
Sprague River
Beatty
Bly
Upper Klamath Lake
Klamath Co.
Swan Lake
Upper Klamath NWR
Klamath Falls
LINK RIVER DAM
Lake Ewauna
A Canal
Dairy
Alkali Lake
Bonanza
HORSEFLY (GERBER)
Gerber Reservoir
Miller Creek
HARPOLD DAM
Lorella
MILLER DIV.
KENO DAM
Keno
JC BOYLE
Midland
Nuss Lake
LOST RIVER DIV.
Spring Lake
Lost River
Klamath River
Bear Valley NWR
Worden
Merrill
Malin
ANDERSON-ROSE DIV.
MALONE DIV. DAM
Willow Valley Reservoir
Oregon
California
COPCO 1&2
IRON GATE
Dorris
Indian Tom Lake
White Lake
Tulelake
Lower Klamath NWR
Lower Klamath Lake
Tule Lake NWR
Tule Lake Sump
Newell
CLEAR LAKE DAM
Clear Lake
Clear Lake NWR
Siskiyou Co.
Modoc Co.
Legend
Dam
City/Town
Major River
Major Highway
Lake
Irrigation Canal
Major Diversion Canal
National Wildlife Refuge
BOR-The Klamath Project
Miles
0 1.5 3 6
U.S. Fish and Wildlife Service
Klamath Falls Office - Klamath Falls, Oregon

EXECUTIVE SUMMARY

INTRODUCTION

This jeopardy biological opinion (BO) and conference report addresses the effects of operation of the Bureau of Reclamation's (Reclamation) Klamath Project (Project) from June 1, 2002 through March 31, 2012 on the endangered Lost River sucker (LRS), endangered shortnose sucker (SNS), threatened bald eagle, and proposed critical habitat for the LRS and SNS (collectively suckers). The Project delivers water to about 220,000 acres of irrigated agriculture in the upper Klamath River Basin (Basin) in south-central Oregon (Klamath County) and northern California (Modoc and Siskiyou counties), as well as to the Tule Lake and Lower Klamath National Wildlife Refuges (NWRs). The Project consists of three main reservoirs with a total surface area of about 100,000 acres, many miles of canals and ditches, and numerous water control structures, pumps, and other structures. Related to the proposed action is operation of PacifiCorp's hydroelectric facilities on the Link River, on the Klamath River and New Earth Corporation's algae harvest facility at the "C-drop" off of the A-canal.

Summary of Recent Consultation History. 1) April 5, 2001 consultation for Reclamation's Klamath Project, 2) January 2002 National Academy of Science's Interim Report that contained a biological analysis of the Service's 2001 BO, 3) March 28, 2002 , two month Interim BO on Reclamation's Klamath Project. This BO exempted incidental take April and May 2002.

Among the primary differences between the 2001 consultation and the 2002 consultation are the facts that: 1) the 2001 BO was a one year consultation for a critically dry year; 2) the 2002 BO is a ten year consultation with all water year types; 3) the 2002 BO contains additional information from the Interim report of the National Academy of Science and other peer review; 4) new information on factors contributing to catastrophic fish die-offs; and 5) the 2002 BO is based on a BA that includes fish screening and fish passage that has been required since 1992, as well as management based on the hydrograph for years 1991-2000, which poses less risk to the species and is consistent with recommendations of the National Academy of Science.

The findings of the January 2002 Interim Report of the National Research Committee on Endangered and Threatened species in the Klamath River are largely in agreement with the Service's findings in its 2001 Biological Opinion. The Interim Report concluded that there is no clear empirical evidence for a relationship between lake levels and catastrophic die-offs of the two sucker species in Upper Klamath Lake. The Service agrees that this relationship is complex and not completely understood. However the Service has established a relationship between lake level and crucial conservation needs of the two endangered suckers including access to foraging, refugial and spawning habitat, dilution of adverse water quality, and suppression of algal growth. These benefits additively improve the "welfare" or condition of the species. The Service will review the final NRC report and will request reinitiation of this BO if appropriate.

New information produced by Tammy Woods of USGS indicates that high runoff caused by storm events, which flush larger than normal quantities of nutrients into Upper Klamath Lake, may lead to die-offs later in the year. Thus, although adequate inflow into Upper Klamath Lake remains important to the welfare of the suckers, studies are showing that other factors need also to be considered and eventually , offset. Adaptive management is an important process that this biological opinion will use to aid in doing this.

LIFE HISTORY AND ENVIRONMENTAL BASELINE

Sucker Biology. The two endangered sucker species (suckers) are endemic to the Basin. The three major Project reservoirs [Upper Klamath Lake (UKL), Clear Lake, and Gerber Reservoir] represent their primary habitats, with UKL representing the principle populations of both species. Tule Lake once supported a large population of suckers but habitat conditions there are now so degraded that only a few hundred suckers remain. Sucker populations in Clear Lake and Gerber Reservoir appear healthy, but their population viability is at risk from reductions in water depth, adverse water quality, and lack of access to spawning areas. Sucker populations in UKL are at risk of extirpation from adverse water quality, loss of habitat, entrainment, and lack of passage.

Environmental Baseline. The environmental baseline for the suckers is characterized by degraded aquatic ecosystems throughout the Basin. The baseline has been adversely affected over the past 150 years by agriculture, grazing, forestry, and to a smaller degree, urbanization. Project effects occur throughout the entire range of both the LRS and SNS and have been a major factor in contributing to the loss or degradation of aquatic habitats in the Basin and the endangered status of the two suckers. Nearly all Basin streams and rivers have been degraded, some seriously, by the loss of riparian vegetation, geomorphic changes, introduction of return flows from agricultural drainage ditches and water pumped from drained wetlands, stream channelization, dams, and flow reductions from agricultural and hydroelectric diversions. Most water bodies in the Basin fail to meet state water quality criteria. Wetland losses have been especially significant for suckers since wetlands provide habitat for larval and juvenile suckers and have crucial water quality functions. Along the perimeter of UKL, about 40,000 acres of wetlands have been diked and drained for agriculture; elsewhere in the Basin, wetland losses are even larger. Lower Klamath and Tule Lakes no longer support suckers or have been reduced to a few hundred acres of suitable habitat.

Restoration of wetland and riparian habitats has been initiated throughout the Basin on private and public lands. In addition, Total Maximum Daily Loads (TMDLs) are being developed. Implementation of these Clean Water Act regulations combined with habitat restoration will bring water quality and habitat improvements and will reduce threats and contribute to the conservation of the suckers. Proposed construction of fish screens at water diversions and of fish passage will also significantly reduce loss of suckers. However, decades will be required for these actions to be fully implemented and functional.

EFFECTS OF THE ACTION

Assumptions. In formulating this BO, the Service made several assumptions, including: 1) on-going sucker monitoring will continue into the indefinite future, 2) the current status in UKL sucker populations will remain relatively stable, and 3) inflow year types will occur in the 10-year period of this proposed action at a similar frequency that they have occurred in the period of record.

Effects. Implementation of the action, as proposed, is likely to have the following effects on the LRS and SNS and their proposed critical habitat:

1. Use of a 70% exceedance forecast to predict water-year types underestimates inflows in 7 out of 10 years, resulting in management to drier water-year types and lower lake levels more often than actual inflows would warrant.

2. The proposed action will increase lake depths in Project reservoirs above the hydrologic baseline during wetter water year types providing water quality benefits, but during drier year types depths will be reduced, likely exacerbating poor water quality conditions.

3. The proposed action, especially in dry and critically-dry water-year types, is likely to increase the frequency and magnitude of small-sized fish kills by increasing the number and extent of areas affected by pre-dawn DO declines during July-October.

4. Project dams increase storage of nutrient-rich storm inflows above the hydrographic baseline. These additional nutrients are likely to increase summer algal biomass in UKL, which adversely affects water quality and may lead to catastrophic fish die-offs similar to those that resulted in the loss of an estimated 80-90% of the adult sucker population in the 1990's, if certain environmental conditions exist. Such events are likely to be infrequent but have a high associated risk for suckers.

5. The proposed lake levels for UKL should provide stable or increasing depths and sufficient access by adult suckers to most of the shoreline spawning habitat during the three wetter year-types. However, under the lake level management proposed for the critically-dry water-year type, sucker spawning habitat will be limited and sucker reproduction will be reduced.

6. The proposed action will generally provide sufficient habitat for larval suckers in most water-year types. However, there is a high risk of larval year-class failure for the Williamson River spawning population of suckers as a result of lake level management proposed for the critically-dry water-year type.

7. The proposed action for UKL maintains summer/fall lake levels at or near the historic late summer baseline of 4140 ft for the above average water-year type, but lake levels drop substantially lower in August and October in the three drier water-year types and this is likely to result in a substantial loss of late-season juvenile sucker habitat in such years and poses a high risk of juvenile year-class failure in critically-dry years.

8. The proposed lake levels reduce late summer/fall adult sucker habitat by as much as 50% in dry and critically dry years. Available adult habitat is further reduced by habitat limitations caused by areas of adverse or lethal water quality during the summer and fall when lake levels and habitat availability are at their lowest.

9. The proposed action provides minimum lake levels necessary to protect the viability of LRS and SNS populations in Clear Lake Reservoir and SNS populations in Gerber Reservoir (LRS not present).

10. The proposed action continues to provide very limited flows to sustain the Tule Lake populations of the LRS and the SNS. Within Tule Lake, suckers will continue to be affected by

adverse water quality conditions and very limited suitable habitat for adult suckers.

11. The proposed action will continue operation of the six primary Project dams, none of which provides suitable passage for suckers. The dams physically isolate sucker populations; prevent genetic exchange between populations; block access to essential spawning, larval, and rearing habitat; cut off escape from adverse conditions downstream; and prevent the return of entrained suckers to upstream habitat and spawning areas. The proposed fish ladder at the Link River Dam should allow spawning adults to pass the dam, but the smaller juvenile and sub-adults will remain isolated downstream where their survival will be reduced by poor water quality conditions.

12. Project water diversions, including dams and hydropower diversions, will entrain millions of larvae and tens of thousands of juveniles, and thousands of sub-adult and adult suckers. This entrainment reduces the population of suckers and limits the amount of recruitment into the adult spawning populations. The screening of A-Canal by 2003 will reduce entrainment losses of juvenile, sub-adult, and adult suckers. However, entrainment of all life stages will continue to occur under the proposed action at the Link River Dam, as well as at other unscreened Project diversions. The number of suckers entrained at the Link River Dam and diversions is likely to increase if suckers that are bypassed from the A-Canal move a short distance downstream.

13. The proposed action will result in application of pesticides in the vicinity of sucker-occupied waterways. We consider pesticide use on private lands to be a potential threat to the LRS and SNS. This threat is minimized when pesticides are used according to label instructions and adequate buffer strips are used adjacent to open water or canals.

Effects to Bald Eagles. The action as proposed will provide the average water delivery by year type to Refuges as occurred in the previous decade. Consequently, the Project will result in a range of adverse effects to bald eagles, but the type and intensity of adverse effects to nesting and wintering eagles is not likely to lead to death or injury of eagles by significantly impairing essential behavioral patterns such as breeding, feeding or sheltering. Therefore, the proposed operation of the Project would not incidentally take bald eagles and is not likely to jeopardize the continued existence of the bald eagle.

CONCLUSION

Jeopardy determination. The ability of the endangered suckers to sustain adverse impacts is more limited now than in the past due to drastic reductions in their populations (numbers), reproductive capacity and distribution. In addition, entrainment reduction measures at Link River Dam, that have been required since 1996, have not yet been implemented. The impacts to suckers from entrainment continues to be an extremely significant adverse impact to the species. Consequently, while the proposed action provides protective measures to the species not previously incorporated, additional measures must still be implemented in order to offset impacts to population, distribution and reproduction sufficient to ensure long-term survival of the species.

Reasonable and Prudent Alternative. A Reasonable and Prudent Alternative (RPA) has been developed for the proposed action that avoids effects that are likely to jeopardize the continued existence of the LRS and SNS and adverse modification of their proposed critical habitat. The RPA requires: a) Reduce

Effects of Adverse Water Quality and Habitat Loss in UKL Resulting From Project Operations; b) Reduce Sucker Entrainment at Link River Dam; and c) Study Factors Affecting Water Quality Leading to Fish Die-offs and Access to Refuge Habitat in UKL; Implement Actions to Reduce Die-off Frequency and Magnitude and Increase Access to Refuge Habitat in UKL

Incidental Take. Incidental take of suckers is anticipated and Reclamation is required to implement reasonable and prudent measures (RPMs) to minimize the impacts of that take. Incidental take of bald eagles is not anticipated.

This BO supercedes all previous Project-related BOs, excepting those BOs associated with Reclamation's application of chemicals.

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Abbreviations

ac-ft	acre-feet	**NMFS**	National Marine Fisheries Service
Act	Endangered Species Act	**NRC**	National Academy of Science Natural Resource Council
ADR	Alternative Dispute Resolution	**NRCS**	Natural Resources Conservation Service
AFA	*Aphanizomenon flos-aquae*	**NWR**	National Wildlife Refuge
AFLP	amplified fragment length polymorphisms	**ODA**	Oregon Department of Agriculture
ASU	Arizona State University	**ODEQ**	Oregon Department of Environmental Quality
BA	biological assessment	**ODFW**	Oregon Department of Fish and Wildlife
BIA	Bureau of Indian Affairs	**ODOT**	Oregon Department of Transportation
BLM	Bureau of Land Management	**OSU**	Oregon State University (Department of Fisheries and Wildlife)
BO	biological opinion	**OWRD**	State of Oregon Water Resources Department
BRD	Biological Resources Division of U.S. Geological Survey	**PCB**	polychlorinatedbiphenyls
C	Celsius	**PIT**	passive integrated transponder
CAFO	confined animal feeding operation	**ppb**	parts per billion
CDFG	California Department of Fish and Game	**pH**	hydrogen ion concentration
cfs	cubic feet per second	**pers. comm.**	personal communication
Chl-a	chlorophyll-a (plant pigment that is measured as an index of algal biomass)	**PRA**	Pacific Recovery Area
CHU	critical habitat unit	**rkm**	river kilometer
cm	centimeter	**RM**	river miles

COPCO	California Oregon Power Company	**RPA**	Reasonable and Prudent Alternative
d	day	**RPM**	Reasonable and Prudent Measure
DDE	dichlorodiphenyldichloroethylene	**RTRM**	relative thermal resistance to mixing
dbh	diameter at breast height	**Service**	U.S. Fish and Wildlife Service
DO	dissolved oxygen	**SL**	standard length
DRD	debris reduction device	**SNS**	shortnose sucker (*Chasmistes brevirostris*)
EPA	Environmental Protection Agency	**SOD**	sediment oxygen demand
ESA	Endangered Species Act	**TAF**	thousand acre-feet
FERC	Federal Energy Regulatory Commission	**TID**	Tulelake Irrigation District
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act	**TL**	total length
FL	fork length	**TMDL**	total maximum daily load
ft	feet (Note: for lake levels, elevations are above mean sea level, USBR datum)	**TMS**	Threshold Management Strategy
GRP	Geographic Response Plan	**TNC**	The Nature Conservancy
h	hour	**TU**	thermal units
HID	Horsefly Irrigation District	**UCD**	University of California, Davis
IT	incidental take	**UKL**	Upper Klamath Lake
KBERO	Klamath Basin Ecosystem Restoration Office	**ug/l**	micrograms/liter (ppb)
KDD	Klamath Drainage District	**UKBWG**	Upper Klamath Basin Working Group
KID	Klamath Irrigation District	**unpub.**	unpublished
KLS	Klamath largescale sucker (*Catostomus snyderi*)	**USACE**	U.S. Army Corps of Engineers
KPOPSIM	Klamath Project Operation Plan Simulation	**uS/cm**	micro-Seimons per centimeter

KSS	Klamath smallscale sucker (*Catostomus rimiculus*)	**USBR**	U.S. Bureau of Reclamation
LOC	level of concern	**USDA**	U.S. Department of Agriculture
LRDC	Lost River Diversion Channel	**USDI**	U.S. Department of the Interior
LRS	Lost River sucker (*Deltistes luxatus*)	**USFS**	U.S. Forest Service
LVID	Langell Valley Irrigation District	**USFWS**	U.S. Fish and Wildlife Service
mg/l	milligrams/liter	**USGS**	U.S. Geological Survey
mi	mile	**WDW**	Washington Department of Wildlife
NAS	National Academy of Science	**WRD**	Water Resources Division of U.S. Geological Survey
NCWQCB	North Coast Water Quality Control Board		

LIST OF APPENDICES

1.0 INTRODUCTION

This document transmits the Fish and Wildlife Service's (Service or USFWS) biological opinion and conference report (BO) based on our review of the Bureau of Reclamation's (Reclamation or USBR) proposed operation of the Klamath Project (Project) in Klamath County, Oregon and Modoc and Siskiyou Counties, California from June 1, 2002, to March 31, 2012, in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). Although Reclamation originally requested consultation on the proposed operation of the Project for the period April 1, 2002 to March 31, 2012, they subsequently requested and completed formal consultation on Project operation for the period from April 1, 2002 to May 31, 2002. At issue are the effects of the proposed action on the endangered Lost River sucker (*Deltistes luxatus*; LRS), endangered shortnose sucker (*Chasmistes brevirostris*; SNS), threatened bald eagle (*Haliaeetus leucocephalus*), and proposed critical habitat for the LRS and the SNS (collectively referred to as suckers). Reclamation's request for formal consultation was received on February 27, 2002.

This BO is based on: (1) information provided in Reclamation's final Biological Assessment (BA) dated February 25, 2002; (2) information presented in previous BAs and BOs addressing operation of the Project; (3) information obtained from Reclamation in meetings regarding operation of the Project, and from the results of ongoing Reclamation field research activities; (4) information, including new information, provided in published and unpublished reports on the biology, distribution, systematics, and status of the affected listed species and the ecosystems upon which they depend**;**(5) communications with field researchers who have conducted, or are now conducting, research on the biology of affected listed species or the ecosystems upon which they depend; and (6) other available commercial and scientific information, including comments and reports received in response to reviews of our April 2001, final BO on the Project and the National Academy of Science Interim Report from the Committee on Endangered and Threatened Fishes in the Klamath River Basin entitled *Scientific Evaluation of Biological Opinions on Endangered and Threatened Fishes in the Klamath River Basin* (National Research Council 2002). A complete administrative record of this consultation is on file at the Service's Klamath Falls Fish and Wildlife Office in Klamath Falls, Oregon.

1.1 CONSULTATION HISTORY

Reclamation has consulted with the Service concerning the effects of operating the Project on federally listed threatened and endangered species since1989. Table 1.1-1 summarizes previous ESA section 7 consultations on the Project.

Table 1.1-1. Consultation history for the Klamath Project.

Date	Subject of Consultation	Affected Listed Species	Determination
June 14, 1989	Formal consultation on the use of acrolein in canals and drains within the Klamath Project service area.	Shortnose Sucker Lost River Sucker	Likely to jeopardize.
August 14, 1991 (superceded by this BO)	Formal consultation on the effects of the 1991 operation of the Klamath Project.	Shortnose sucker Lost River sucker Bald Eagle American Peregrine Falcon	Likely to jeopardize the sucker species. No jeopardy to the Bald Eagle. No effect to the American Peregrine Falcon.
January 6, 1992 (superceded by this BO)	Formal consultation on the effects of the 1992 operation of the Klamath Project (interim biological opinion).	Shortnose Sucker Lost River Sucker Bald Eagle American Peregrine Falcon	Not likely to jeopardize the sucker species or the Bald Eagle. No effect to the American Peregrine Falcon.
March 27, 1992 (superceded by this BO)	Reinitiation of formal consultation on the effects of the 1992 operation of the Klamath Project.	Shortnose Sucker Lost River Sucker Bald Eagle American Peregrine Falcon	Likely to jeopardize the sucker species. No jeopardy to the Bald Eagle. No effect to the American Peregrine Falcon.
May 1, 1992 (superceded by this BO)	Reinitiation of formal consultation on the effects of the 1992 operation of the Klamath Project at Clear Lake Reservoir.	Shortnose Sucker Lost River Sucker Bald Eagle American Peregrine Falcon	No jeopardy to the affected species.
July 22, 1992 (superceded by this BO)	Formal consultation on the effects of long-term operation of the Klamath Project.	Shortnose Sucker Lost River Sucker Bald Eagle American Peregrine Falcon	Likely to jeopardize the sucker species. No jeopardy to the Bald Eagle. No effect to the American Peregrine Falcon.
February 22, 1993 (superceded by this BO)	Reinitiation of formal consultation on long-term operation of the Klamath Project at Upper Klamath Lake. operations.	Shortnose Sucker Lost River Sucker	One-year modification of lake elevation 4141.0 on March 1, 1993.
August 11, 1994 (superceded by this BO)	Reinitiation of formal consultation on long-term operation of the Klamath Project, with special reference to operations at Clear Lake Reservoir.	Shortnose Sucker Lost River Sucker Bald Eagle American Peregrine Falcon	Established new minimum elevation for Clear Lake Reservoir.
February 9, 1995	Formal consultation on the use of pesticides and fertilizers on Federal lease lands, and acrolein and herbicide use on Klamath Project rights-of-way; reinitiation of formal consultation on the use of acrolein for aquatic weed control in Reclamation canals and drains.	Shortnose Sucker Lost River Sucker Bald Eagle American Peregrine Falcon Applegate's Milkvetch	Not likely to jeopardize the sucker species. No effect to the Bald Eagle, American Peregrine Falcon, or Applegate's Milkvetch.
February 2, 1996	Reinitiation of consultation on the use of pesticides and fertilizers on federal lease lands, and acrolein and herbicide use on Klamath Project rights-of-way.	Shortnose Sucker Lost River Sucker Bald Eagle American Peregrine Falcon	Not likely to jeopardize the affected species.

July 15, 1996 (superceded by this BO)	Reintiation of **c**onsultation on PacifiCorp and The New Earth Company **o**perations, as permitted by the Bureau of Reclamation under the Klamath Project**.**	Shortnose Sucker Lost River Sucker	Not likely to jeopardize the affected species.
April 2, 1998 (superceded by this BO)	Amendment to July 22, 1992 BO to extend date for completion of A-canal screen until 2002**.**	Shortnose Sucker Lost River Sucker	Not likely to jeopardize the affected species.
April 20, 1998 (superceded by this BO)	Amendment to the 1992 BO to cover **o**peration of Agency Lake Ranch **i**mpoundment**.**	Shortnose Sucker Lost River Sucker	Not likely to jeopardize the affected species.
April 21, 1998 (superceded by this BO)	Amendment to July 15, 1996**,** consultation on PacifiCorp and The New Earth Company **o**perations, as permitted by the Bureau of Reclamation under the Klamath Project**.**	Shortnose Sucker Lost River Sucker	Not likely to jeopardize the affected species.
July 13, 1998 (superceded by this BO)	Amendment to the 1992 BO dealing with Anderson-Rose releases**.**	Shortnose Sucker Lost River Sucker	Not likely to jeopardize the affected species.
April 15, 1999 (superceded by this BO)	Amendment to the 1996 BO addressing lowered water levels in Upper Klamath Lake to reduce risk of flooding in spring 1999**.**	Lost River Sucker Shortnose Sucker	Not likely to jeopardize the affected species.
August 18, 1999	Amendment to the 1995 BO on use of pesticides and fertilizers on leased lands and use of acrolein in canals operated by the Langell Valley Irrigation District.	Lost River Sucker Shortnose Sucker	Not likely to jeopardize the affected species.
September 10, 1999 (superceded by this BO)	Revised amendment to the 1992 BO to cover operations and maintenance of Agency Lake Ranch impoundment**.**	Lost River Sucker Shortnose Sucker	Not likely to jeopardize the affected species.
April 5, 2001 (superceded bythis BO)	Reinitiation of formal **c**onsultation on long-term operations of the Klamath Project**; a** one year consultation at the request of Reclamation**.**	Lost River Sucker Shortnose Sucker Bald Eagle	Likely to jeopardize the sucker species. No jeopardy to the Bald Eagle.
April 13, 2001 (superceded by this BO)	Reinitiation of formal **c**onsultation on releases at Anderson Rose Dam**.**	Lost River Sucker Shortnose Sucker	Not likely to jeopardize the sucker species. Concur with drought year assessment.
August 22, 2001 (superceded by this BO)	Amendment to the April 5, 2001 BO on Klamath Project operations to cover Safety of Dams modification of Clear Lake Dam**.**	Lost River Sucker Shortnose Sucker Bald Eagle	Not likely to jeopardize the affected species.
September 12, 2001 (superceded by this BO)	Amendment to the April 5, 2001 BO to cover the Link River Topographic Survey Fish Passage Assessment**.**	Lost River Sucker Shortnose Sucker	Not likely to jeopardize the affected species.
September 21, 2001 (superceded by this BO)	Formal consultation for revision of the 2001 Klamath Project Sucker Salvage Plan to cover the Klamath Falls Airport Runway Safety Area Extension Project and Station 48 Maintenance Project**.**	Lost River Sucker Shortnose Sucker	Not likely to jeopardize the affected species.
March 28,2002 (superceded by this BO)	Formal consultation for continued operation of the Klamath Project from April 1, 2002 to May 31, 2002**.**	Lost River Sucker Shortnose Sucker Bald Eagle	Not likely to jeopardize the affected species.
Under review	Formal consultation on the effects of A Canal Fish Screen and Link River Dam Fishway Facilities Construction and Operation	Lost River Sucker Shortnose Sucker Bald Eagle	Under review

This BO supercedes previous Project-related BOs, except for those related to acrolein and other chemical applications. Our understanding is that Reclamation is consolidating new information concerning the chemical application-related BOs and will reinitiate consultation on these actions in the near future.

Following the issuance of the Service's April 5, 2001 BO regarding the continued operation of the Project, numerous comments expressing concern related to the science used in our analysis were received from Reclamation and others. In response to these comments, the Service asked Oregon State University (OSU) to conduct an independent peer review of that document. The University of California, Davis (UCD) also conducted a blind peer review of the BO. In addition, the Departments of the Interior and of Commerce contracted with the National Academy of Science (NAS) to assess the scientific basis for the biological assessments and opinions issued by Reclamation, the Service and the National Marine Fisheries Service (NMFS). Under that contract, NAS will conduct a two-part assessment of endangered and threatened fish in the Klamath Basin. The first part of the assessment examines the scientific evidence behind the 2001 biological assessment prepared by Reclamation and the 2001 biological opinions issued by the Service and NMFS. The first phase of the assessment resulted in what NAS describes as an "interim report" that was issued in February 2002. The second phase of the assessment which is to "take a broader approach to evaluation of evidence related to the welfare of the endangered or threatened species" is scheduled to be completed by March 30, 2003.

The Oregon State University review of the final BO found:

> "The Final BO, dated April 5, 2001, was responsive to peer review and new information. It is thorough, well-documented, and professional."
>
> "In summary, the final BO makes a strong case for revising the conditions of the 1992 BO. It does so based primarily on the congressional instruction to provide "benefit of the doubt", supplemented by a belief of greater imperilment of the species, failure to implement prior requirements, and an increased concern for water quality. It makes a good case that the 4 in 10 year compromised elevation of 4137 ft might create jeopardy, but it does not address whether compromised elevations or their frequency can be considered reasonable and prudent in the future. The BO also presents an argument for raising the un-compromised elevation one foot to 4140 ft. The argument is primarily based on a potential indirect benefit to insure against low wind speeds, but the amount of insurance provided by one foot of lake elevation is not described. We estimate that lake elevation compensation for the lowest wind speeds may be unattainable but suggest more rigorous analyses are necessary. (Markle et al. 2001)

The University of California at Davis faculty review found:

> "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 for 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." (UCD 2001)

The principal findings of the NAS Natural Resource Council (NRC) Committee on Endangered and Threatened Fishes in the Klamath River Basin interim report are as follows:

> "The NRC committee concludes that all components of the biological opinion issued by the USFWS on the endangered suckers have substantial scientific support except for the recommendations concerning minimum water levels for Upper Klamath Lake. A substantial data-collection and analytical effort by multiple agencies, tribes, and other parties has not shown a clear connection between water level in Upper Klamath Lake and conditions that are adverse to the welfare of the suckers. Incidents of adult mortality (fish kills), for instance, have not been associated with years of low water level. Also, extremes of chemical conditions considered threatening to the welfare of the fish have not coincided with years of low water level, and the highest recorded recruitment of new individuals into the adult populations occurred through reproduction in a year of low water level. Thus, the committee concludes that there is presently no sound scientific basis for recommending an operating regime for the Klamath Project that seeks to ensure lake levels higher on average than those occurring between 1990 and 2000. At the same time, the committee concludes that there is no scientific basis for operating the lake at mean minimum levels below the recent historic ones (1990-2000), as would be allowed under the USBR proposal. Operations leading to lower lake levels would require acceptance of undocumented risk to the suckers**"** (NRC 2002a).

As discussed in greater detail in subsequent sections of this document, UKL levels and conditions in the lake affect different life stages of suckers at different times of the year. Although the Service also found that existing analyses have not demonstrated an empirical relationship between lake levels and fish die-offs that affect adult suckers in August/September, the Service believes there is evidence of a relationship between factors affecting sucker die-offs and lake levels. The interactions of conditions such as wind, inflow, water quality, cloud cover, habitat, and lake level in UKL are complex and studies to date have not been designed to specifically evaluate the relationships between these factors. Evidence that relationships between lake levels, environmental variables, and fish die-offs exist is most likely to come from directed studies.

However, many other effects of lake levels are observable and measurable and past studies have demonstrated a positive relationship between lake levels and factors affecting suckers. For example, between a number of factors in the spring, the ability of suckers to reach spawning habitat and successfully spawn may be precluded if water depths are not sufficient. Sucker access to spawning sites and water depths at spawning sites are incrementally reduced as lake levels are lowered. Spawning locations, sucker accessibility, and water depths above spawning areas are observable and measurable. Studies of larval and juvenile suckers have demonstrated use of emergent marsh habitat by both of these life stages. The amount of emergent marsh habitat available to suckers is incrementally reduced as lake levels are lowered. During June and July as water levels are lowered, the amount of available mash habitats is reduced an juveniles move to rocky substrates. Available edge habitat at different water levels is also observable and measurable. These relationships are discussed in greater detail in subsequent sections of this document.

The factors affecting the survival of a sucker year class from the larval stage to the adult spawning stage is complex and the relationship to water levels is less clear. Sucker survival is likely tied to water quality, and UKL water quality is strongly influenced by climatic conditions that vary from year to year. Suckers may live to be 30 to 40 years old and do not reach reproductive maturity until 5 to 7 years of age. Between the larval stage and entering the spawning population, year classes have to survive five to seven years of environmental conditions. Fish from the 1991 spawn appear to be a strong year class. However, data with which to determine the survival rate of the 1991 fish in subsequent low water years are not available for analysis. Data on sucker recruitment into adult population from the mid 1990s onward is not yet available for analysis because these fish have not matured. Years of good water quality during sucker spawning and rearing, as in 1991, may compensate for reduced habitat availability at lower water levels. Conversely, mortality induced by poor water quality on young of the year suckers may offset the beneficial effects of maintaining available nursery habitats. Numerous factors must be examined in evaluating survival of a year class to adult populations from the larval to the adult life stage. Another factor significantly affecting suckers, for example, is entrainment. These relationships and effects are also discussed in greater detail in subsequent sections of this document.

All comments received from the reviewers mentioned above and others have been considered by the Service and relevant information incorporated into this BO. When developing its BO, the Service is required to use the “best scientific and commercial data available” to determine if the proposed action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. An action that jeopardizes the continued existence of a species is defined as an action that “reasonably would be expected, directly or indirectly, to reduce the reproduction, numbers, or distribution of that species.” 50 CFR § 402. Following completion of the NAS/NRC final report, the Service and Reclamation will review the report, as well as any additional new information received, to determine if reinitiation of formal consultation on the Project is necessary.

1.2 Other Relevant Activities Associated with this Consultation

In May 1996, Reclamation initiated formal consultation on the effects of PacifiCorp and New Earth activities on listed species that are permitted by or contracted with Reclamation in conjunction with operation of the Project. Reclamation's 1996 BA proposed a number of actions to be carried out by PacifiCorp and New Earth including, among other things, entrainment reduction studies, sucker nursery habitat restoration at Tulana Farms, endangered sucker and water quality monitoring, and perhaps most important, entrainment reduction devices at the intakes for the eastside and westside hydropower diversions. The Service issued a BO that concluded that the proposed action, which included fish screens, was not likely to jeopardize the endangered suckers. The BO was amended later in 1996 to require the screens to be in place at Link River Dam when algae harvest started or June 1, 2000, whichever was earlier.

To date, screening of the intakes for the eastside and westside canals has not occurred and adult, sub-adult and juvenile suckers are still being entrained at Link River Dam. New information developed since 1996 indicates that incidental take associated with the release of water into these canals (that is through gates leading to the hydropower diversions which empty into the Link River downstream of the dam) is significant and exceeds that anticipated in 1996. Incidental take coverage was extended by letter amendment on a yearly basis while fish screen design was being considered. In Reclamation's 2001 BA the proposed action included the release of water into the eastside and westside canals.

In the 2001 BO, the Service included an Incidental Take Statement that addressed entrainment at these intakes. The 2002 BO provided a reasonable and prudent alternative that required entrainment to be reduced by January 2004, and a draft entrainment reduction plan for Link River Dam and a schedule for implementation were to be submitted to the Service by July 2001 unless consultation was reinitiated on the1996 BO. The 2001 BO specifically states that "[t] his BO supercedes all previous Project-related BOs, including....." p. iii of 2001 BO. At this point in time, there has been no re-initiation of consultation on the 1996 BO and no entrainment reduction plan submitted to the Service.

On August 30, 2001, the Service submitted recommendations to Reclamation concerning the timing and coordination associated with future consultation on the Project.

On February 1, 2002, Reclamation officially transmitted the "Draft Biological Assessment of the Effects of the Proposed Actions Related to Klamath Project Operation April 1, 2002 - March 31, 2012 on Federally-Listed Threatened and Endangered Species" for Service and public review. One copy was hand carried to the Service's Klamath Falls Fish and Wildlife Office by Reclamation on January 28, 2002**,** and a copy of the draft BA was placed on a Department of the Interior web site.

On February 27, 2002, Reclamation submitted its final BA, 31 days before the expiration of the Service's 2001 BO on the Project.

On March 22, 2002**,** Reclamation submitted an additional BA and a request for formal consultation to address the effects of operating the Project in accordance with their February 27, 2002 BA for the period from April 1, 2002 to May 31, 2002, at which time the BO addressing the effects of the proposed 10-year operation plan should be completed. The Service issued an interim BO addressing Reclamation's March 22 request on March 28, 2002. A copy of this BO is attached as Appendix A.

On March 29, 2002, Reclamation submitted an another BA and a request for formal consultation to address the effects of construction and operation of the A-Canal Fish Screen and the Link River Dam Fishway Facilities on the endangered Lost River sucker, the shortnose sucker, and the bald eagle. Over the past year, Reclamation has convened several meetings with an interagency working group, including the Service, to develop and finalize plans for screening of A-canal and a fish ladder at Link River Dam. This BA is currently under review.

2.0 DESCRIPTION OF THE PROPOSED ACTION

2.1 Definition of the Action Area

The "action area" is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" 50 CFR §402.02. Based on information contained in the description of the proposed action in Reclamation's February 25, 2002 Final Biological Assessment, and in the "Status of the Species", and "Effects of the Action" sections of this document, we have determined that the action area for this consultation extends from Iron Gate Dam upstream in the Klamath River to Link River Dam, including Link River Dam, Link River and Lake Ewauna; Upper Klamath Lake (UKL) to its highwater line, and tributaries as far upstream as are affected by Project operations; Clear Lake and Gerber Reservoir to their high water lines, and tributaries as far upstream as are affected by Project operations; the entire Lost River from Clear Lake Dam to and including the Tule Lake sumps, including all of Miller Creek, and any tributaries of the Lost River as far upstream as they are affected by Project operations. Also included in the action area are dams, canals, drains, and facilities owned or operated, or related to Reclamation's Project, and the approximately 220,000 acres of irrigated land serviced by the Project. The Project is located in Klamath County in southern Oregon and Modoc and Siskiyou Counties in northern California. Service actions on Refuge lands serviced by the Project are not included because they undergo separate section 7 ESA consultation.

2.2 Reclamation's Proposed Action

Reclamation proposes to operate the Project from April 1, 2002, through March 31, 2012, in a manner consistent with the historical operation of the Project from water year 1990 through 1999 and in such a way as to achieve or exceed the average end of month elevations by inflow year type in UKL for the 1990 through 1999 period, as set forth in Table 5.1 on pages 53 and 54 of the BA, and as set forth in Tables 5.6 and 5.7 on pages 58 and 59 of the BA for Gerber Reservoir and Clear Lake, respectively.

In addition the proposed action includes:

- a commitment for periodic coordination between Reclamation, the Service, NMFS, Klamath Basin Tribes, PacifiCorp, and irrigation districts;

- installation of a permanent fish screen at the A-Canal headworks and other measures to reduce and monitor fish entrainment into the A-Canal from UKL;

- installation of fish passage facilities at Link River Dam; and

- undertaking feasibility studies authorized by the Klamath Basin Water Supply Enhancement Act to study enhancing the water supply available for Project use.

Since the 2002 BA was submitted to the Service, Reclamation has requested formal consultation on the effects of the A-Canal fish screen and Link River Dam Fishway Facilities construction and operation (USBR 2002d). Reclamation has agreed to have the fish screen facility constructed and operational by April 1, 2003, and has scheduled construction of the Link River Dam Fishway to begin in July 2003. The Service considers these commitments to be an important part of this proposed action.

Reclamation incorporates by reference the project description from the 1992 BA, the 2001 BA, and a November 2000 Report entitled, "Historic Klamath Project Operations." Appendix B contains a detailed project description based on these sources. The discussion below addresses those features with the most potential for significant effects to listed species.

In a memorandum subsequent to submitting the BA, Reclamation also states that water deliveries to the Klamath Basin National Wildlife Refuge Complex (Refuge) will be similar to those experienced during the period Water Year 1990 - Water Year 1999 (USBR 2002b; USBR 2002c). The effects of Project operations on the Refuge are not analyzed in the BA.

Tables on pages 53, 54, 58, and 59 of the BA indicate the Project will be operated in accordance with four water inflow year types: (1) above average (>500,000 acre feet of inflow); (2) below average (312,000-500,000 acre feet of inflow); (3) dry (185,000-311,000 acre feet of inflow); and (4) critically dry (<185,000 acre feet of inflow). The inflow year types are determined based upon the Natural Resource Conservation Services's (NRCS) April forecast of inflows to UKL at the 70% exceedance level. Project water management would be determined using Reclamation's water-routing model (KPOPSIM) that simulates Project operation and the effects of varying water deliveries on overall Project operation (USBR 2001). During the 10-year period from 1990 through 1999, all water inflow year types were represented: there were six above average years, two critically dry years, one below average year, and one dry water year (USBR 2002b).

The BA additionally notes that in "rare instances" the Project may be operated at minimum lake and reservoir levels rather than at average minimum levels (USBR 2002b). For this reason, data for the operation at minimal levels have not been included in the BA nor has an analysis been performed (M.Ryan, D. Sabo, M. Beuttner, pers. comm. 2002). "Rare instances" are not defined nor are criteria specified that would clarify how Project operations would occur at these minimum observed levels. Therefore, operation to minimum lake levels would be outside conditions evaluated in this consultation. Should Reclamation predict operation to minimum lake levels at a future date, reinitiation of consultation will be necessary.

2.2.1 Four-Step Analysis

On page 11 of the BA, the following four-step process is to be used to develop Project operating criteria for UKL, Gerber Reservoir, and Clear Lake (USBR 2002):

> **Step 1** Determination of Water Year Type. Reclamation will determine the water inflow year type (above average, below average, dry, or critical dry) using a 70 percent exceedance factor and NRCS's April 1 runoff forecast.
>
> **Step 2** Preliminary Calculation of Project Water Supply. Reclamation will estimate the annual water supply that would be available for irrigation and refuge deliveries under the following criteria:
>
> UKL, Gerber Reservoir, and Clear Lake Levels. Reclamation will estimate the available supply based on lake levels no lower than the minimum end-of-month elevations for the ten-year period.
>
> Klamath River flows below Iron Gate Dam. Reclamation will estimate the available supply based on operations that differ, depending on year type as follows:
>
>> For above average and below average years, Reclamation will estimate available supply based on daily average river flows no lower than the respective ten-year minimums or Federal Energy Regulatory Commission (FERC) flows, whichever are greater.
>>
>> For dry and critically dry years, Reclamation will estimate available supply based on daily average river flows no lower than the observed ten-year minimums.
>
> **Step 3** Second Calculation of Project Water Supply (Proposed Action). Reclamation will estimate annual water supply available for proposed irrigation and refuge deliveries using the following criteria:
>
> UKL, Gerber Reservoir, and Clear Lake. Regardless of water inflow year type, lake levels no lower than the average end-of-month elevations for the ten-year period (1990 through 1999).
>
> Klamath River flows below Iron Gate Dam. These flows differ based on water inflow year type as discussed below.
>
>> For above average and below average years - daily average river flows no lower than their respective ten-year minimums or FERC flows, whichever is greater (as proposed in Step 2 above).
>>
>> For dry and critically dry years - daily average river flows no lower than their

actual, observed ten-year averages plus a pulse of water to facilitate smolt downstream migration (10,000 acre-feet in April).

Step 4 Determine Water Bank Requirements. Implementation of the proposed action will require the use of a Project water bank. The size of the water bank will be determined by calculating the difference in Project water supply between the proposed operations (Step 3, above) and preliminary calculations (Step 2, above). Reclamation anticipates annual water bank requirements of up to 100,000 acre feet, depending on year type.

After development of the operating criteria, Reclamation proposes to operate the Project in a manner that results in UKL, Gerber Reservoir, and Clear Lake water levels no lower than the average end-of-month elevations by year type for the ten-year period. The levels are set forth in Tables on pages 53, 54, 58, and 59 of the BA. Relevant parts of these tables are presented below:

2.2.2 Upper Klamath Lake

Table 2.2.2-1. Upper Klamath Lake end-of month, minimum elevations (ft) by inflow year types resulting from Reclamation's proposed action (Reclamation 2002b, Table 5.1).

Month	Above Average	Below Average	Dry	Critically Dry
October	4139.7	4138.8	4138.2	4137.3
November	4140.3	4139.0	4139.0	4138.1
December	4141.0	4138.8	4139.7	4138.9
January	4141.5	4139.5	4140.3	4140.1
February	4141.9	4141.7	4140.4	4141.1
March	4142.5	4142.7	4141.7	4142.0
April	4142.9	4142.8	4142.2	4141.9
May	4143.1	4142.7	4142.4	4141.4
June	4142.6	4142.1	4141.5	4140.1
July	4141.5	4140.7	4140.3	4138.9
August	4140.5	4139.6	4139.0	4137.6
September	4139.8	4138.9	4138.2	4137.1

2.2.3 Clear Lake

Table 2.2.3-1. Clear Lake end-of month, minimum elevations (ft) by inflow year types resulting from Reclamation's proposed action (Reclamation 2002b, Table 5.7).

Month	Above Average	Below Average	Dry	Critically Dry
October	4531.2	4526.8	4522.5	4520.4
November	4531.0	4526.8	4522.5	4520.5
December	4531.5	4526.7	4522.8	4520.7
January	4532.4	4527.0	4522.9	4522.6
February	4531.9	4531.1	4527.0	4524.6
March	4534.6	4531.5	4527.1	4524.6
April	4535.3	4531.2	4526.9	4524.6
May	4535.3	4530.6	4526.4	4523.6
June	4534.7	4529.9	4525.7	4522.8
July	4533.8	4528.8	4524.5	4521.8
August	4532.8	4527.7	4523.5	4520.6
September	4532.1	4527.1	4522.8	4520.6

2.2.4 Gerber Reservoir

Table 2.2.4-1. Gerber Reservoir end-of month, minimum elevations (ft) by inflow year types resulting from Reclamation's proposed action (Reclamation 2002b, Table 5.6).

Month	Above Average	Below Average	Dry	Critically Dry
October	4822.6	4804.4	4798.0	4801.6
November	4822.7	4804.3	4798.0	4801.7
December	4824.8	4804.4	4798.0	4802.1
January	4826.7	4804.5	4798.2	4807.7
February	4825.4	4817.5	4804.8	4811.8
March	4833.6	4821.3	4804.2	4812.3
April	4835.0	4821.2	4808.3	4811.8
May	4834.2	4818.9	4808.1	4809.8
June	4832.8	4816.1	4803.6	4808.1
July	4830.1	4812.3	4799.2	4805.9
August	4827.6	4808.7	4798.6	4803.6
September	4825.3	4804.6	4798.1	4801.7

2.2.5 Coordination

Reclamation proposes to meet with the Service, NMFS, Klamath Basin Tribes, PacifiCorp, and irrigation districts on a periodic basis, as needed, to coordinate activities and discuss water supply conditions, species status, and available options for Project operation. Reclamation proposes to work with the Service and NMFS to jointly prepare an annual report documenting the preceding year's activities and accomplishments (USBR 2002).

2.2.6 Reduction of Fish Entrainment and Barriers to Fish Passage

The only Project facility with a fish screen is the diversion to Agency Lake Ranch. All other facilities are unscreened and there is no fish passage, except for the fish ladder at Link River Dam which was designed to pass trout. Entrainment of endangered suckers and lack of connectivity between sucker populations have been previously identified as some of the major effects of Project operations (USBR 2001; USFWS 1992; USFWS 1993; USFWS 1996; USFWS 1998; USFWS 2001). Reclamation proposes to prepare for Service approval a multi-year plan to design and install screens and ladders at other diversions in the Project service area by January 1, 2003. The number or location of diversions is not identified nor is a potential schedule for implementation of this plan provided in Reclamation's 2002 BA.

A-Canal Entrainment Reduction

In accordance with the Reasonable and Prudent Alternative set forth in the Service's 1992 BO on the Project, Reclamation proposes to prepare a final design for a permanent fish screen at the A-Canal headworks by September 1, 2002. Construction of the screen is proposed to begin by December 1, 2002, and be completed and operational by the beginning of the irrigation season on April 1, 2004. Since the 2002 BA for long-term operation of the Project was submitted to the

Service, Reclamation has requested formal consultation on the effects of the A-Canal fish screen and Link River Dam Fishway Facilities construction and operation (USBR 2002d). Reclamation now has agreed to have the fish screen facility constructed and operational by April 1, 2003.

Fish Passage at Link River Dam

Reclamation proposes to study and implement specific measures to provide fish passage at Link River Dam. A draft conceptual Link River fish passage plan was completed by Reclamation in May 2001. In its BA, Reclamation proposed to prepare final fish passage designs by January 2004 based in part, on the results of a two-year study starting in 2002. The estimated completion date of fish passage measures was January 2006, two years following approval of the final designs. Subsequent to transmitting its 2002 BA to the Service, Reclamation requested formal consultation on the effects of the Link River Dam Fishway Facilities construction and operation and has scheduled construction of the Link River Dam Fishway to begin in July 2003 (USBR 2002d).

Reclamation proposes to continue to conduct annual salvage of suckers stranded below outlet structures of dams and in the canal systems. Salvage operations are proposed to be conducted in a manner consistent with efforts during previous years. Annual reports describing salvage operations are to be prepared by Reclamation and sent to the Service, California Department of Fish and Game, Oregon Department of Fish and Wildlife, and Klamath Tribes by January 1 of each year (USBR 2002b).

2.2.7 <u>Operation of Klamath Basin National Wildlife Refuge Complex</u>

The Refuge Complex consists of the Tule Lake,and Clear Lake National Wildlife Refuges (NWRs) in the Lost River drainage and the Lower Klamath Lake, Upper Klamath, Bear Valley, and Klamath Marsh NWRs in the Klamath River drainage. Of these, the Tule Lake NWR and Lower Klamath Lake NWR overlay the Project. The Upper Klamath Lake and Clear Lake NWRs encompass part or all of the lake surface, respectively. The Refuges are under the jurisdiction of the Service.

The lease land program on the Tule Lake and the Lower Klamath Lake NWRs is administered by Reclamation pursuant to a 1977 cooperative agreement with the Service. Water is diverted from Project storage facilities to provide for crop production on private lands and refuge leased lands located within the Project service area (Table 7, USBR 2001).

The refuges also receive water directly from the Project for refuge management use. Reclamation's 2002 BA provides no information concerning Project operation as it affects water delivery to the Refuge. However, Reclamation subsequently notified the Service that water deliveries to the Refuge will be similar to those experienced during the period from Water Year 1990 - Water Year 1999 (USBR 2002c). For purposes of this BO, the Service assumes that water deliveries to the Refuge will meet or exceed the average minimum deliveries during critical years from 1990 through 1999.

2.2.8 Implement Klamath Basin Water Supply Enhancement Act (Public Law 106-498)

Reclamation proposes to undertake feasibility studies authorized by the Klamath Basin Water Supply Enhancement Act to study enhancing the water supply available for Project use. The studies would include, but not be limited to: (1) increasing the water storage capacity of Gerber Reservoir and UKL; (2) developing off-stream water storage in the Lower Klamath Lake area; and (3) a water storage leasing program. Implementation of actual projects and/or programs would be contingent upon the results of the feasibility studies, Congressional approval, authorization, and appropriation, and completion of appropriate environmental compliance activities (USBR 2002b). At this time, there are no specific actions being proposed by Reclamation.

The following are Project features not specifically discussed in Reclamation's BA, but are incorporated by reference in Reclamation's 2001 BA for the Project and in its report entitled "Klamath Project Historic Operation, November 2000."

2.2.9 Klamath Straits Drain (Pumping Plants E, EE, F & FF)

The Klamath Straits Drain, constructed in 1941 and operated by Reclamation, begins at the Oregon-California border and proceeds north to the Klamath River. It is a 60 ft wide x 4-6 ft deep x 8.5 mile long earthen channel with re-lift pumping stations. Water is re-lifted twice by pumps and is then discharged to the Klamath River. The Klamath Straits Drain is located in the Lower Klamath NWR which in turn receives drainage water from the Project and Tule Lake NWR. The Klamath Straits Drain was enlarged in 1976 to provide additional capacity to drain private agricultural lands and refuge lands. Maximum flow in the drain is 600 cubic feet second (cfs). The Klamath Straits Drain is operated at levels that will provide adequate drainage to both private lands and Refuge lands. The pumps are operated to meet the flow conditions within the drain. Water quality conditions are monitored continuously near the outlet of the channel to the Klamath River.

2.2.10 Tule Lake Sump

The Tule Lake Sump, the down stream extent of the Lost River drainage, is among the Project features that would be operated as in the past. As such, a minimum surface elevation of 4034.6 feet will be maintained at this location from April 1 through September 30 of each year. A minimum elevation of 4034.0 feet will be maintained at Tule Lake Sump from October 1 to March 31 of each year (USBR 2001). In addition a minimum flow of 30 cfs will be maintained in the Lost River below Anderson-Rose Dam for at least 4 weeks beginning April 15 of each year to allow spawning and return of adult and larval suckers (USBR 2001).

2.2.11 Lost River Dams/Diversion Facilities

Reclamation proposes to operate Malone, Wilson, and Anderson-Rose dams and associated diversion facilities consistent with historic operations (USBR 2001).

2.2.12 Lost River Diversion Canal

The Lost River Diversion Channel (LRDC) connects the Lost and Klamath River and is an important feature of the Project since it allows water to be moved between these two sub-basins. Presently it can flow either east or west, depending on Lost River flows and water demands within the Project. In winter (non-irrigation season), almost the entire Lost River flow is diverted into the LRDC at the Wilson Reservoir Dam. Water in the LRDC flows downstream into the Klamath River. Winter flows that exceed the capacity of the LRDC are spilled into the historic Lost River channel, which flows into the Tule Lake Sump. As the irrigation season begins in the spring, the Station 48 Canal withdraws water from the LRDC and provides delivery of irrigation water to areas south of Klamath Falls. When the Station 48 Canal summer water demands exceed westward flowing LRDC flows, excess irrigation demands are met with water that is withdrawn from the Klamath River. Thus, water from the Klamath River typically flows eastward through the project site when irrigation demands are high (e.g., late spring-summer) and water from the Lost River flows westward through the Project service area when irrigation demands are minimal and after the growing season (e.g., early November through March). In addition, waters from UKL may enter into the Lost River system via the A-Canal, and thus into the LRDC, when excess and return flows drain back into the Lost River watershed from the B, E, and F irrigation canals. All of these canals likely transport endangered suckers since none are screened (USFWS 2001).

2.2.13 Agency Lake Ranch

In 1998, Reclamation acquired the 7,123-acre Agency Lake Ranch on the west side of Agency Lake at the north end of UKL. The ranch property, comprised of former agricultural croplands and pasture, is being used to store additional water for Project use that would otherwise be spilled to the Klamath River during periods of high runoff. In 2000, approximately 15,000 acre-feet of additional water was stored on the ranch and subsequently pumped into Agency Lake for overall Project purposes. Reclamation proposes to continue operation of Agency Lake Ranch to store Project water as described in a April 17, 1998, letter to the Service. Reclamation has started a process for developing a long-term operations plan for the property (USBR 2001).

2.2.14 Monitoring of Sucker Populations

Reclamation proposes to continue to support UKL sucker population status studies to determine if sufficient progress is being made toward their protection and recovery. The objectives of this monitoring effort include: obtaining adult population indices and year-class structure; and collecting information focused on evaluation of management and ecosystem restoration actions (USBR 2001).

2.2.15 Link River Diversion Dam and Upper Klamath Lake

Link River Dam, also known as Link River Diversion Dam, is a feature of the Project that was constructed in 1921 by the corporate predecessor of a company now known as PacifiCorp. After construction of the dam, ownership was transferred to the United States. Link River Dam is operated by PacifiCorp pursuant to a 1956 contract with Reclamation that provides for regulation of UKL levels and Klamath River flows, although Reclamation reserves the right to take control of the facility. Water diverted from UKL at Link River Dam provides irrigation for the Project service area and flood control. Through its Annual Operations Plan, Reclamation directs PacifiCorp to release a certain amount of water at certain times based on irrigation needs, flood control, and in past years downstream ESA needs. PacifiCorp then determines whether the water is release through gates in the dam that lead downstream to Link River or through gates that lead to the eastside and westside canals will be released through the dam structure itself or through hydroelectric facilities located on either side of the dam.

The reservoir regulated by the dam, UKL, is for the most part a natural lake that covers an area of 85,000 acres at water surface elevation 4143.3 feet above mean sea level. It has an active storage capacity of 523,700 acre-feet between elevations 4143.3 and 4136 feet and an inactive storage capacity of 211,300 acre-feet between elevations 4136 and 4126 feet. The dead storage volume below elevation 4126 feet has not been determined.

An unusual condition exists at Link River Dam in that hydraulic control of large outflows from UKL is established at a reef located at the south end of the lake, approximately 0.4 miles upstream from the dam. A 100-foot-wide channel was cut through the reef to an invert elevation of 4131 feet when the dam was constructed; the remaining portion of the reef is at an approximate invert elevation of 4138 feet. Because of the controlling influence of this reef, it is possible during large flood events to have reservoir water surface elevations in UKL higher than the top of the dam at an elevation of 4145.0 feet, while water surface elevations between the dam and the reef are below the top of the dam, provided that the dam gates are opened sufficiently to pass the water that flows over the reef. At the maximum reservoir water surface elevation of 4143.3 feet, the maximum reef discharge is 8,500 cfs (USBR Website). Prior to construction of the Link River Dam, UKL levels fluctuated between 4140 and 4143 feet (USBR 2001).

Link River Dam is a reinforced concrete buttress and slab diversion structure consisting of multiple slide gate and stoplog bays with a common operating deck at elevation 4145.0 feet. It has a structural height of 22.0 feet, a hydraulic height of 8.0 feet, and a crest length of 435.0 ft. There is a total of 44 flow-through outlet or spillway bays with crest elevations from 4129 ft to 4135 ft. One spillway bay has a fish ladder on its downstream side that was constructed to pass trout and does not provide adequate passage for suckers. The gates provide discharge of UKL water to the Link River and also serve as the headworks for the eastside and westside canals which are used by PacifiCorp to generate hydropower.

2.16 <u>PacifiCorp and The New Earth Company</u>

PacifiCorp and The New Earth Company (New Earth) are two private corporations that conduct activities related to the Project. New Earth is permitted by Reclamation to harvest algae from a Project canal (C-Drop), and permitted by PacifiCorp to harvest algae from the eastside and westside canals. The operation of PacifiCorps hydroelectric project is not part of this consultation. As noted previously, Reclamation contracts with PacifiCorp for the operation of Link River Dam. PacifiCorp also operates hydroelectric facilities associated with the eastside and westside canals. Through its annual operations plans and pursuant to the contract between Reclamation and PacifiCorp, Reclamation directs PacifiCorp to release water for Project irrigation and flood control, and in past years for downstream endangered species needs. It is the Service's understanding that PacifiCorp then decides whether to release the water through the bays directly to the river or through the bays which lead to the eastside and westside canals.

Once water is released into the eastside and/or westside canals, it passes through turbines located downstream and then returns to the Link River below the dam and above Lake Ewauna and the Klamath River. Water released through the bays that lead to the canals would otherwise be held back by the dam or be released through the dam via bays that discharge water into the Link River. The west side facility generates up to approximately 0.6 megawatts of electricity. The east side facility generates up to approximately 3.2 megawatts of electricity. Reclamation's direction to release water from UKL via the Link River Dam has effects on suckers that are more fully discussed in the "Effects of the Action" section below. The hydroelectric facilities, including the canals, pre-date the dam and operated independently of the Project prior to dam construction via independent headgates. When the dam was constructed, the headgates for the hydroelectric facilities were built into the dam and are now a part of the dam. In addition, the hydroelectric facilities are interrelated and interdependent with the Project to the extent that the facilities would not operate but for the water that is released from UKL in conjunction with the Project.

Reclamation did not include PacifiCorp or New Earth in its request for consultation on the basis that the impacts of the operation of the eastside and westside canals are addressed in a 1996 BO with Reclamation (D. Sabo, B. Davis, USBR, pers. comm. 2002). Reclamation's 1996 BA proposed a number of actions including, entrainment reduction studies, sucker nursery habitat restoration, endangered sucker and water quality monitoring, and perhaps most important, entrainment reduction devices at the intakes of the eastside and westside canals. PacifiCorp and New Earth each committed to performing various elements of the proposed action. PacifiCorps primary commitment was the restoration at Tulana Farms. New Earth's primary commitment was the installation of fish screens. Restoration of Tulana Farms was anticipated to significantly increase the number of surviving sucker larvae to benefit the species as a whole. PacifiCorp, New Earth, Reclamation, the Service, The Nature Conservancy, and the NRCS cooperatively proposed funding, restoring and maintaining this property. The habitat was to be designed and managed to benefit riverine and lake water quality, reduce larval predation, and substantially increase larval sucker habitat in historic locations. This property was acquired and restoration has been initiated but is not complete.

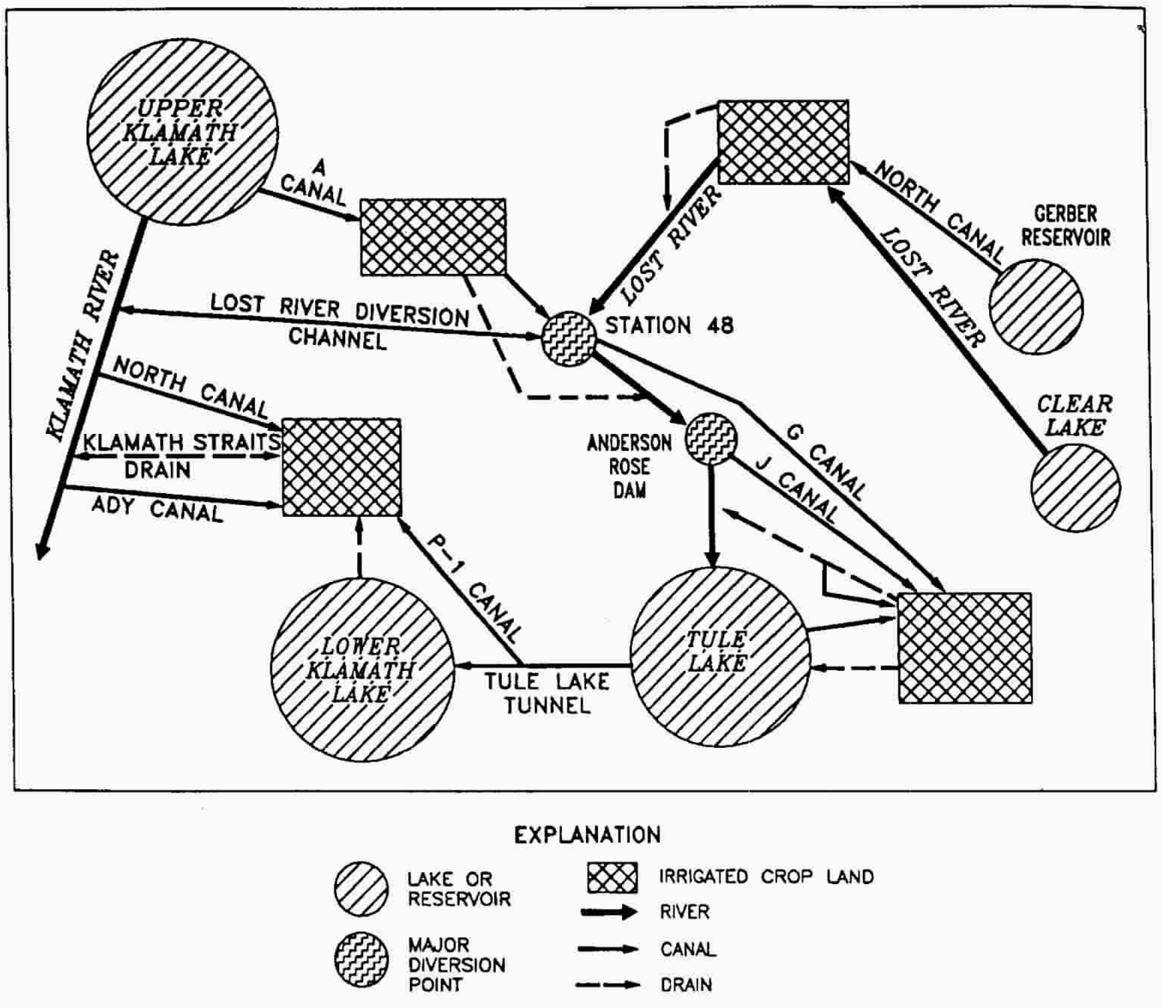
At this point the proposed screening of the eastside and westside canals has not been implemented. New information developed since 1996 indicates that incidental take at the intakes is significant, exceeding that anticipated in 1996. Incidental take coverage was extended by letter amendment on a yearly basis while fish screen design was being considered. Reclamation's 2001 BA includes the operation of the Link River Dam including the release of water into the eastside and westside canals as part of the proposed action. The Service's 2001 BO on the Project included an Incidental Take Statement that addressed these releases and PacifiCorps and New Earth operations through March 31, 2002; that BO also indicated that Reclamation should reinitiate formal consultation regarding the operation of PacifiCorp and New Earth facilities or submit a screening plan in 2001, with screening to be in place by January 2004. As an interim measure, until screening could be implemented, diversions for the PacifiCorp intakes at Link

River Dam were to be curtailed or significantly reduced during August and September when sucker entrainment is most significant. In August and September 2001, PacifiCorp curtailed diversion to the west penstock and reduced diversions into the east penstock to no more than 200 cfs at night to reduce incidental take of suckers. To date, reinitiation of formal consultation has not been requested, and screening associated with diversion to the east and west penstocks has not been implemented.

2.3 Project Operations

The Project uses water held in UKL (Klamath River System) and in Gerber and Clear Lake Reservoirs (Lost River system). The distribution system delivers water via a system of canals to lands in the Langell Valley, Poe Valley, Klamath Irrigation District, Tule Lake area, and Lower Klamath Lake area. The primary diversion points include the Malone and Miller Creek Diversion Dams in the Langell Valley, diverting Lost River (Clear Lake releases) and Miller Creek (Gerber Reservoir releases) respectively; the Lost River Diversion Dam and Channel, control diversions into and out of the Klamath River; the A-Canal diverts water from UKL to the Project, controlling water to the Klamath Irrigation District as well as the Poe Valley and the Tule Lake areas; the Anderson-Rose Diversion Dam on the Lost River, which also diverts water to the Tule Lake area; and the Ady Canal, which diverts water from the Klamath River into the Lower Klamath Lake area. In addition, Project irrigators divert directly from both the river systems and UKL (USBR 2000a). Of these facilities, only the Agency Lake Ranch has a fish screen. Fish passage in not provided at any of the Project facilities, except for the fish ladder at Link River Dam which was designed to pass trout. Although suckers have been found in the ladder, it is not believed to provide adequate passage (Ott 1990; PacifiCorp 1997; M. Buettner, pers. comm. 2002). Figure 2.3-1 is a schematic diagram which displays the movement of water through the Project area.

Figure 2.3-1. Schematic diagram showing movement of water through the Project area. Adapted from USBR (1992a).



Typical water delivery operations under the Project begin in late fall, when the Ady and North Canals are used to deliver water from the Klamath River to lands throughout the Lower Klamath Lake area. This water is used to flood-irrigate private lands, federal lease lands, and Lower Klamath NWR lands. The drain water is returned to the Klamath River via the Straits Drain. Winter flooding is the primary pattern of irrigation in this area of the Project. Irrigation and Refuge water deliveries, however, continue throughout the year. Diversions in the Ady and North Canals range from a low during the summer months of 100 cfs to a high of 500 cfs during the late fall and winter.

In late March or early April, the A-Canal diversions from UKL begin. Flows generally begin at about 500 cfs to charge the canal system, with a gradual increase to a peak of near 1000 cfs in May or June (USBR 1992a). This diversion serves the largest area and delivers the most water of any Project feature. Water deliveries typically continue into October. Drainage water from lands irrigated by this canal can return in one of two different directions. Some drainage water returns to the Klamath River with the remainder flowing into the Lost River for reuse by other districts and the Tule Lake NWR (USBR 1992a). New Earth operates its algae harvest facility at the C drop of A-Canal (USBR 1996). Agriculture returns from the Project, approximately 400 cfs in the summer, enter the Klamath River through the Straits Drain canal upstream of Keno Dam. In the fall and winter, flood water and irrigation drain water from the Lost River Basin are added to the total flow of the Klamath River upstream of Keno via the Lost River Canal. Such inflow may be as high as 3,000 cfs per month, but is usually from 200 to 1,500 cfs (PacifiCorp 2000).

Diversions at Miller and Malone Diversion Dams generally begin in April with flows of about 200 cfs. Flows reach a peak of about 400 cfs and are stopped in about October. These diversions serve about 30,000 acres in the Langell Valley. Drainage water from this system returns to the Lost River.

Diversions at Anderson-Rose Dam generally begin in mid-March with flows of 200 cfs. Flows reach a peak of about 450 cfs and are stopped during October. Anderson-Ros Dame diversions serve the Tule Lake area. All the drainage flows enter the Tule Lake Sump.

The Tule Lake NWR receives water from the Tule Lake area and from the Lost River. Since the Lost River Basin was a naturally closed basin, Reclamation constructed a pump and tunnel system (pump "D") from Tule Lake to Lower Klamath NWR. Return agricultural flows accrue to Tule Lake and are reused for irrigation before the water is ultimately passed through the pump system to Lower Klamath Lake where it is used for irrigation and refuge operations. Finally, the water is returned to the Klamath River via the Straits Drain.

In an average year, Gerber Dam, the source of water for the Miller Diversion Dam, releases about 40,000 acre-feet of irrigation water. Clear Lake releases during an average year will be about 36,000 acre-feet. In an average year, UKL is operated to stay within a set of operational guidelines that provide for irrigation storage, flood protection, ESA requirements, and Tribal trust responsibilities. All water that is not needed to regulate within these guidelines is released to the Klamath River. Irrigation releases from UKL average from 350,000 to 450,000 acre-feet through A-Canal, Lost River Diversion, and other canals.

The Project also modifies flows in the Lost River, Link River, and the Klamath River. Lost River flows are significantly reduced below the Lost River Diversion Dam and Anderson-Rose Diversion Dam (USBR 1992). PacifiCorp, under the direction of Reclamation, operates its Klamath River Hydropower Facilities to meet upper UKL levels and downstream flows in the Klamath River below Iron Gate Dam (PacifiCorp 2000). Natural stream flows in the Project area follow the typical western pattern of very high flows in the spring followed by very low flows in the late summer and fall. The Project now tends, in most years, to temper the magnitude of these extremes and to change the natural timing of these flow patterns (USBR 2000a).

3.0 STATUS OF THE SPECIES: Shortnose and Lost River Suckers

3.1 Listing History

The LRS and SNS were federally listed as endangered on July 18, 1988 (USFWS 1988). At the time of listing, perceived threats to the species included: 1) loss of historical populations and range; 2) habitat loss, degradation and fragmentation; 3) drastically reduced adult populations; 4) overharvesting by sport and commercial fishing; 5) large summer fish die-offs caused by declines in water quality; 6) lack of significant recruitment; 7) hybridization with the other two sucker species native to the Klamath Basin; 8) potential competition with introduced exotic fishes; and 9) the inadequacy of existing regulatory mechanisms to provide for the conservation of these species. These threats, and others that have been recognized since these species were listed, are discussed below under “ Current Threats and Conservation Needs.”

3.2 Current Threats and Conservation Needs

The threats to the LRS and SNS are discussed below along with the conservation needs that address each threat and the general status of the species relative to that threat (see Appendix C for more detailed discussions). The specific status of each LRS/SNS population is then discussed below by area (e.g., Status: Upper Klamath Lake). The term “conservation needs” is defined as those actions or conditions necessary to bring an endangered or threatened species to the point at which protection under the Endangered Species Act (Act) is no longer necessary. The discussion below addresses the primary threats recognized at the time of listing and two additional threats recognized since listing, lack of passage and entrainment.

3.2.1 <u>Loss of historical populations and reduction in range</u>

> Conservation Need : Establish a sufficient number of viable, self-sustaining populations of the LRS and SNS in as much of their historical range as possible. Multiple populations provide resiliency in response to localized extirpations caused by adverse conditions such as prolonged drought, contaminant spills, disease and catastrophic water quality declines. Multiple populations also help ensure the genetic diversity of the species and improve its ability to adapt to changing environmental conditions.

The historical range of LRS and SNS has been severely reduced by drainage and management of Lower Klamath and Tule Lakes. Lower Klamath Lake no longer supports suckers, and the populations in Tule Lake are reduced to a few hundred adults. Both species were once very abundant and were critical food resources for Native Americans and white settlers in the upper Klamath River Basin (Cope 1879; Gilbert 1898; Howe 1968). It was estimated that the aboriginal harvest at one site on the Lost River may have been 50 tons annually (Stern 1966). Settlers built a cannery on the Lost River and suckers were also processed into oil and salted for shipment. In 1900, the *Klamath Republican* newspaper reported that "mullet," as suckers were referred to, were so thick in the Lost River that a man with a pitch fork could throw out a wagon load in an hour. In 1959, suckers were made a game species under Oregon State law, and snagging suckers in the Williamson and Sprague River was popular with locals and out-of-town sportsmen (Bragg 2001). By 1985, Bienz and Ziller (1987) estimated the harvest had dropped by about 95%. Based on this information, the game fishery was terminated in 1987, just prior to federal listing of these species under the Endangered Species Act.

Historically, both LRS and SNS occurred throughout the Upper Klamath Basin, with the exception of the higher, cooler tributaries dominated by resident trout and the upper Williamson, which is isolated by the Williamson Canyon. At the time of listing, LRS and SNS were reported from UKL, its tributaries, Lost River, Clear Lake Reservoir, the Klamath River, and the three larger Klamath River reservoirs (Copco, Iron Gate, and J.C. Boyle). The general range of LRS and SNS had been substantially reduced from its historic extent by the total loss of major populations in Lower Klamath Lake, including Sheepy Lake, and Tule Lake (USFWS 1988). The Klamath River reservoir populations receive individuals carried downstream from upper reaches of the river, but they are isolated from the Upper Klamath Basin by dams and show no evidence of self-sustaining reproduction (Desjardins and Markle 2000). The current geographic ranges of LRS and SNS have not changed substantially since they were listed and only two additional SNS and one LRS populations have been recognized since 1988. They all occur in isolated sections of the Lost River drainage, within the historical ranges of the species, and include an isolated population of SNS in Gerber Reservoir and a small population (limited to several hundred adults) of each species in Tule Lake.

3.2.2 <u>Habitat loss, degradation, and fragmentation</u>

> Conservation Need : Provide adequate quantity and quality of habitat to meet the needs of all life-history stages of the LRS and SNS. Adequate habitat is crucial to ensure recruitment and support viable populations.

Aquatic habitat has been substantially altered or destroyed in the Klamath Basin. Many previously occupied areas no longer support suckers, and crucial habitat for larvae and juveniles is often unavailable due to water management in critical rearing areas such as UKL. The Klamath Basin has lost extensive areas of emergent marshes and open lake environments that were previously used by the LRS and SNS. Lower Klamath Lake no longer supports suckers, and available habitat in Tule Lake is now limited to a few hundred acres or less. Conditions in the Lost River have limited suckers to a few primary reaches of the river. In UKL emergent vegetation that is crucial to the survival of larval and juvenile suckers, is greatly reduced in extent and often fragmented into isolated patches along the shoreline or left dry as lake levels drop. Current habitat availability and conditions in the Klamath Basin are greatly dependent on water management. In UKL availability of larval and juvenile sucker habitat is constrained by lake level, with much of the available habitat lost by mid to late summer as water levels decline.

Adult sucker habitat is also limited by low summer/fall lake levels.

3.2.3 Small or isolated adult populations [reproduction]

> Conservation Need : Increase and maintain population sizes of the LRS and SNS. Populations must be maintained at levels that ensure genetic viability and provide sufficient genetic variability to allow the species to respond to environmental and ecological variability.

Important portions of the suckers' historical range, including the Lost River, Tule Lake, Clear Lake and Gerber Reservoir, contain populations which are either very small or are isolated by dams. LRS and SNS populations in Tule Lake and the Lost River (LRS in particular) appear to have declined to less than a thousand adult individuals. The primary threat to these populations is limited habitat due to adverse water quality, sedimentation, impoundment, isolation from spawning areas and lack of significant recruitment. The Clear Lake and Gerber Reservoir populations of the LRS and SNS are isolated by dams from the rest of the Klamath Basin. Although these populations appear to be maintaining themselves, each is at risk by habitat reduction during prolonged drought with no ability to replenish the gene pool through immigration of individuals from neighboring areas.

3.2.4 Isolation of existing populations by dams [passage]

> Conservation Need: Provide for adequate passage for all life-stages of suckers past dams. Both sucker species are dependent on free-passage along river corridors to ensure genetic exchange between populations, to gain access to spawning areas, and to allow young fish entrained downstream to return to their parent populations.

There are nine primary dams within the natural range of the LRS and SNS, none of these dams provide suitable passage for suckers. The dams physically isolate sucker populations, prevent genetic exchange, block access to essential habitat, cut off escape from adverse conditions downstream, and prevent the return of entrained suckers to upstream habitat and spawning areas. The proposed fish ladder at the Link River Dam is intended to allow spawning adults to pass the dam, but the smaller juvenile and sub-adult suckers will remain isolated downstream. Completion of the Link River fish ladder is not expected until at least January 2006.

3.2.5 Poor water quality leading to large fish die-offs and reduced fitness

> Conservation Need: Improve water quality to a level where adverse effects are not sufficient to threaten the continued persistence of the LRS and SNS. Lethal water quality conditions in UKL are the primary cause of mortality in adult suckers.

Water quality in UKL consistently reaches levels known to be stressful to suckers and periodically reaches lethal levels in August and September, resulting in catastrophic die-offs. Major fish die-offs have been recorded at UKL since the late 1800's but have increased in frequency in the last few decades. Small, localized fish die-offs have been observed annually on UKL since 1992 when extensive research and monitoring activities began. In 1995, 1996 and

1997 a series of major fish kills in UKL reduced adult sucker populations of LRS and SNS in UKL by an estimated 80-90 percent.

Adverse water quality conditions in Clear Lake and Gerber Reservoirs is primarily determined by shallow reservoir depths, which reduce available habitat and cause declines in dissolved oxygen (DO), resulting in stress to the suckers and reducing their overall fitness. Available habitat in Tule Lake is severely limited by shallow depths and further limited by seasonal declines in water quality. All three water bodies are subject to potential winter fish-kills when poor water quality, especially low DO, is associated with prolonged ice-cover and shallow depths.

3.2.6 Lack of significant recruitment

> Conservation Need: Increase the frequency and magnitude of recruitment into the spawning populations of both LRS and SNS. For a population to survive, survival and recruitment of young fish into the spawning population must be sufficient to offset adult mortality and allow populations to increase to sustainable levels that provide adequate resiliency against fish kills, disease, infrequent recruitment, and other factors.

Since listing in 1988, the UKL sucker populations have not maintained recruitment levels sufficient to offset adult mortality caused by catastrophic fish die-offs. Successful recruitment of substantial new cohorts of the LRS and SNS into the UKL spawning populations has only occurred 2-3 times in the last seventeen years (1984-2001). During this time there have been four catastrophic, and many minor fish die-offs, caused by adverse water quality (see discussion below under the status of suckers in UKL). Sucker recruitment in Clear Lake and Gerber Reservoirs appears to be maintaining viable populations. There is no evidence of successful sucker recruitment in the small Tule Lake population or in the lower Klamath River reservoirs.

3.2.7 Entrainment into irrigation and power diversion channels

> Conservation Need: Substantially reduce entrainment of larval, juvenile and adult LRS and SNS. Entrainment represents a major cause of mortality in young suckers and adults within the Upper Klamath Basin. For recovery of LRS and SNS it is crucial to increase survival of young life-stages, so that they can recruit into the adult spawning population, and reduce mortality of adults; both are necessary for the establishment of viable, self-sustaining, natural populations.

Entrainment of suckers into Klamath Basin irrigation and hydro-power diversions is documented to account for the loss of millions of larvae, tens of thousands of juveniles, and hundreds to thousands of adult suckers each year (Gutermuth et al. 1997, 1998b, 1999, 2000a, 2000; Harris and Markle 1991; Markle and Simon 1993; Simon and Markle 2001; USBR 2002b). There are currently no fish screens at principal diversions that meet State or Federal screening criteria. Reclamation is currently in the final design phase for construction of a fish screen at the A-Canal, which is scheduled to be operational by July 22, 2003. However, the proposed facility will not prevent entrainment of larval fish under about 30 mm, and so larval entrainment of suckers will continue. Suckers prevented from entering A-Canal will still have to contend with entrainment just downstream at the Link River Dam and diversions. The fact that adequate screening has not been provided anywhere within the Project after nearly a century of operation is considered by the Service to be a major factor imperiling and retarding the recovery of the two endangered suckers.

3.2.8 Hybridization with other native Klamath sucker species

> Conservation Need: Maintain rates of hybridization appropriate to the evolutionary framework in which the suckers are evolving. Excessive hybridization can result in the loss of genetic diversity, fitness and evolutionarily unique lineages.

Hybridization was believed to be widely occurring in Klamath Basin suckers and was considered a threat by the Service at time the LRS and SNS were listed. From 1997-2001 several different laboratories (Oregon State University; University of California, Davis; and Arizona State University) have used independent strategies to identify morphological and genetic characters to address questions regarding reproductive isolation, classification, systematic relationships, and the extent of hybridization among Klamath Basin suckers. The preliminary evidence suggests that some hybridization may be natural within the Klamath Basin sucker fauna, and hybridization may not represent as great a threat as was thought at the time the LRS and SNS were listed. However, the biological and conservation implications of hybridization, as well as the degree to which recent man-made changes to the Klamath Basin have altered the natural rate of hybridization, are still not completely understood.

3.2.9 Potential competition with and predation by non-native fishes

> Conservation Need: Ensure that LRS and SNS populations can withstand the adverse effects of competition and predation from introduced fishes.

At least eighteen species of non-native fishes have been introduced and have established populations in the Upper Klamath Basin. Little is known about the ecological and competitive interactions of the introduced fishes with the native suckers, and this limits our ability to assess their impact. Many of the introduced fishes are predators that could prey on larval and juvenile suckers. One species of particular concern is the fathead minnow, *Pimephales promelas*. This small minnow first appeared in UKL in 1974, and has increased in abundance to an extent where it is frequently the most abundant fish captured there and in the Lost River. Fathead minnows generally occupy the same near-shore habitat as larval and juvenile suckers and may be significant predators on the larvae. It is not practical to remove non-native fishes once they have become established. However, habitat management to the benefit of native suckers, especially larvae and juveniles, and recovery of the adult population to a point where reproduction offsets the adverse effects of competition will allow the suckers to sustain viable populations in the face of increased competition and predation.

3.2.10 Overharvesting by sport and commercial fishing

> Conservation Need: Reduce harvest to levels that allow for viable natural populations to maintain themselves.

LRS and SNS were once very abundant and were critical seasonal foods of Native Americans and white settlers in the upper Klamath River basin. In 1959, suckers were made a game species under Oregon State law, and snagging suckers was extremely popular with both locals and out-of-town sportsmen. By 1985, the estimated harvest had dropped by about 95%. Based on this information, the fishery was terminated in 1987, just prior to Federal listing. As a result of the regulatory termination of sport and commercial fishing, overharvest is no longer considered a threat to the species.

3.3 Status of LRS and SNS Populations

3.3.1 Status: Upper Klamath Lake

Upper Klamath Lake: Population Estimates

Accurate population estimates of the adult sucker populations in UKL do not exist. Early estimates of relative declines in abundance prior to listing came primarily from the sport fishery catch records (Andreasen 1975; Bienz and Ziller 1987; Bragg 2001; Cooperman and Markle 2001; Eugene Register-Guard 1967; Golden 1969; USFWS 1988). Subsequent estimates have been based primarily on tagging efforts in the Williamson River and recovery of tagged fish that died during catastrophic fish die-offs in 1995-1997 (Bienz and Ziller 1987; Perkins 1996; Perkins et al. 1997; Shively 2002a). The highly complex ecological and physical variability of the UKL system, the large size of the lake, sampling constraints, and substantive unmet statistical assumptions in the calculation of tag/recapture results make absolute population estimates unattainable from current information and quantitative interannual comparisons of estimates inappropriate (Shively 2002a; see further discussion in Appendix C).

Prior to listing, several spawning populations of suckers were apparently lost from Upper Klamath Lake, as evidenced by the absence of suckers at many historical spawning areas in the lake (Andreasen 1975; Cooperman and Markle 2001; Perkins et al. 1998). In the late 1980's and early 1990's, at least six additional spawning areas, including the Wood River, have either ceased to show evidence of use or shown severe declines in use (Cooperman and Markle 2001; Markle and Simon 1993; Simon and Markle 1997).

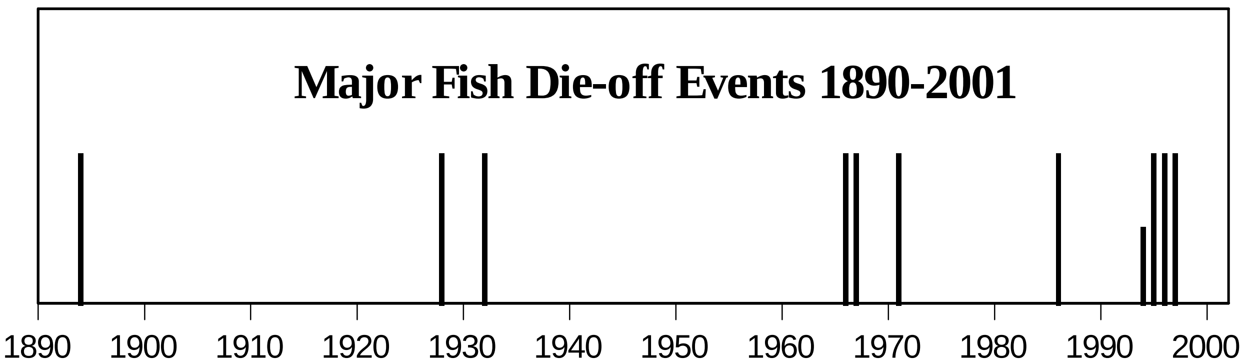
Given the above difficulties in estimating sucker population sizes, the available information suggests that LRS and SNS population numbers have fluctuated somewhere between a few thousand to a few hundred thousand adults of each species in UKL within the period since 1988 (Cooperman and Markle 2001). While these estimates are very broad, it is important to consider that recovery of the suckers depends not on absolute numbers, but rather, on the viability of the populations and their ability to sustain themselves into the future. This aspect of viability is dependent on the ability of the species to balance adult mortality with successful recruitment of new individuals into the adult spawning population.

In UKL, the major source of adult mortality is periodic catastrophic fish die-offs. Adult mortality must be compensated by the production of successful juvenile year classes (cohorts) and then by the survival and recruitment of those cohorts into the spawning population at a rate in excess of adult mortality.

Upper Klamath Lake : Fish Die-offs

Water quality in UKL consistently reaches levels known to be stressful to suckers and periodically reaches lethal levels in August - September, resulting in catastrophic die-off events (Bienz and Ziller 1987; Buettner 1997; Foott 1997; Gilbert 1898; Holt 1997; Loftus 2001; Perkins et al. 2000b; Scoppettone 1986; Scoppettone and Vinyard 1991; USBR 1996a). Major fish die-offs have been recorded since the late 1800's but have increased in frequency in the last few decades (Figure 3.3.1-1). Small, localized fish die-offs have been observed annually on UKL since 1992, when extensive research and monitoring activities began.

Figure 3.3.1-1. Occurrence of major fish die-off events since 1890. Note increased frequency since 1960. Based on available scientific records, newspaper articles and observations of local residents.



The magnitude of fish kills in the 1990's have been estimated by scientific observers to be approximately tens of thousands of suckers for each event (Bienz and Ziller 1987; Buettner 1997; Gilbert 1898; Perkins et al. 2000b; Scoppettone 1986; Scoppettone and Vinyard 1991). Accurate estimates are not possible due to the difficulty of counting dead, floating fish in a lake the size of UKL and due to the undeterminable numbers of dead suckers that are out of sight on the bottom. Also, numerous fish-eating birds inhabit the lake, likely eat many of the smaller fish, since large numbers of birds are frequently noted as the first sign that fish are stressed or dying. A general estimate of the magnitude of the 1996 die-off, based on estimates of population numbers before the 1996 die-off and the 1997 estimate, suggests that the 1996 die-off killed about 50% of the adult populations. The three major die-offs in 1995-1997 may have reduced the pre-1995 population by about 80-90%. This is supported by declines in the abundance of adults spawning in the Williamson River (Figure 3.3.1-4; Cunningham et al. 2002)

Upper Klamath Lake : Production of Larvae and Juveniles

Oregon State University scientists (Markle et al. 2000b, Simon 2002, Simon et al. 2000a, 2000b; Simon and Markle 2001) have monitored the relative abundance of larval suckers in UKL consistently since 1995. Larval catch rates were similar in 1995, 1996, 1997 and 1999, but were significantly lower in 1998 and 2000; data are not yet available for 2001 (Figure 3.3.1-2; Simon and Markle 2001). Juvenile abundance was low in 1995, 1997, 1998 and 2001, but relatively high in 1996, 1999 and 2000 (Figure 3.3.1-3; Simon 2002).

Figure 3.3.1-2. Relative annual abundance of larval suckers in Upper Klamath Lake. Larval trawl catch rates of age 0 suckers in Upper Klamath Lake, 1995-2000. Error bars are 95% confidence intervals. Adapted from Simon and Markle, 2001, page 31.

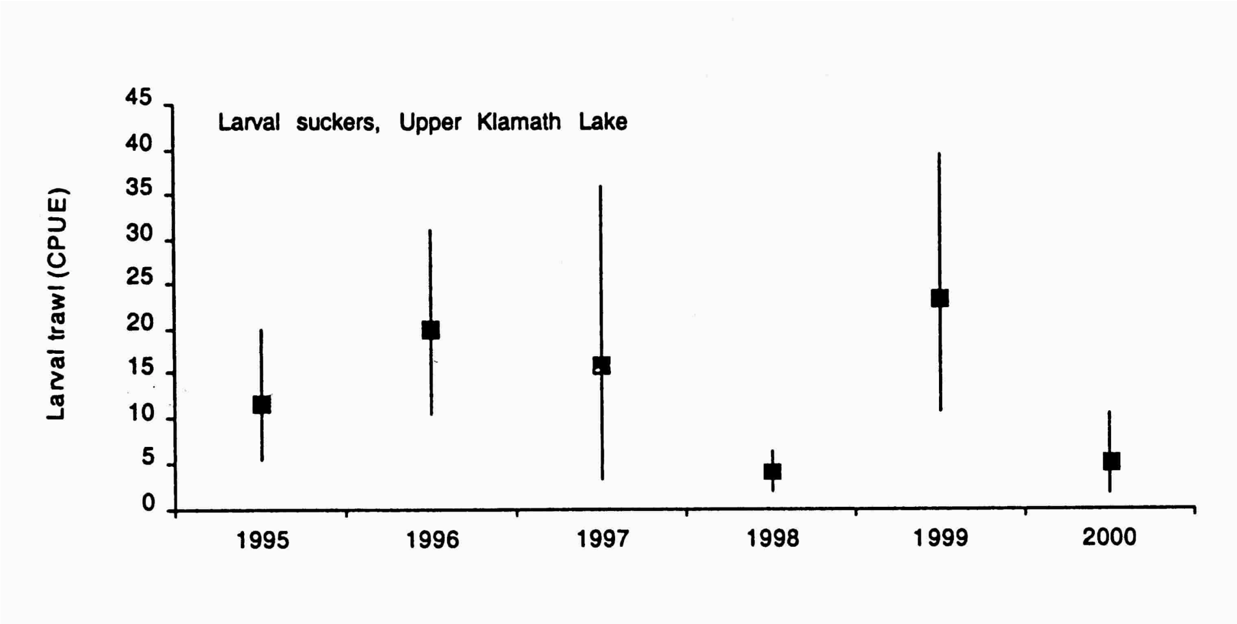
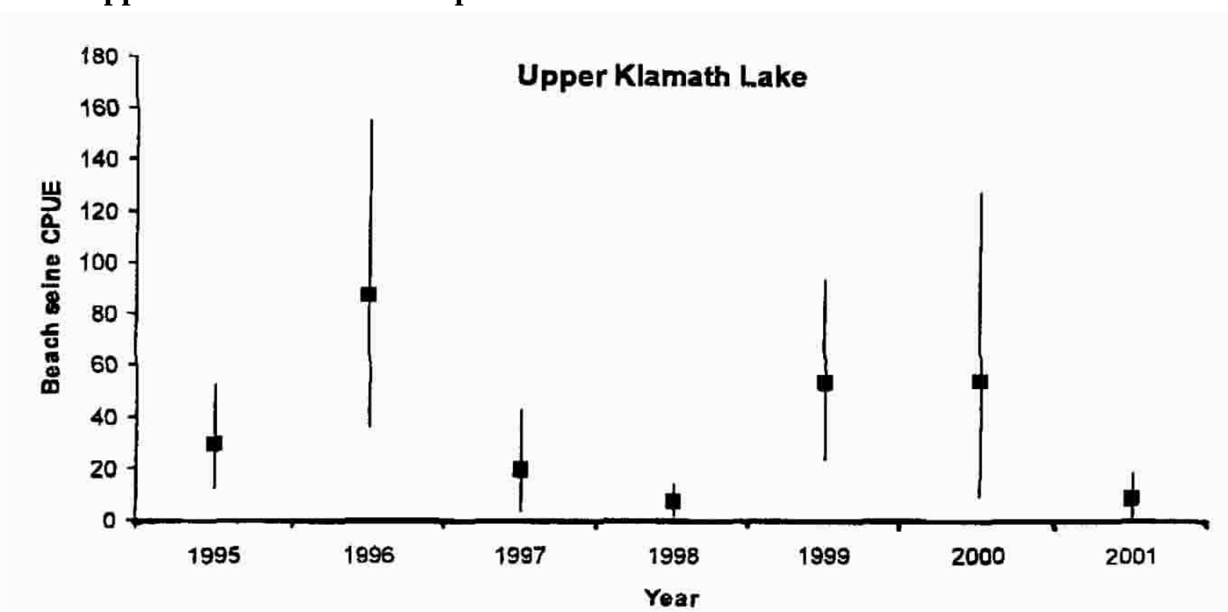


Figure 3.3.1-3. Relative abundance of juvenile suckers in Upper Klamath Lake, 1995-2001 (June-August). Late June - August age 0 sucker beach seine CPU in Upper Klamath Lake. Adapted from Simon 2002.



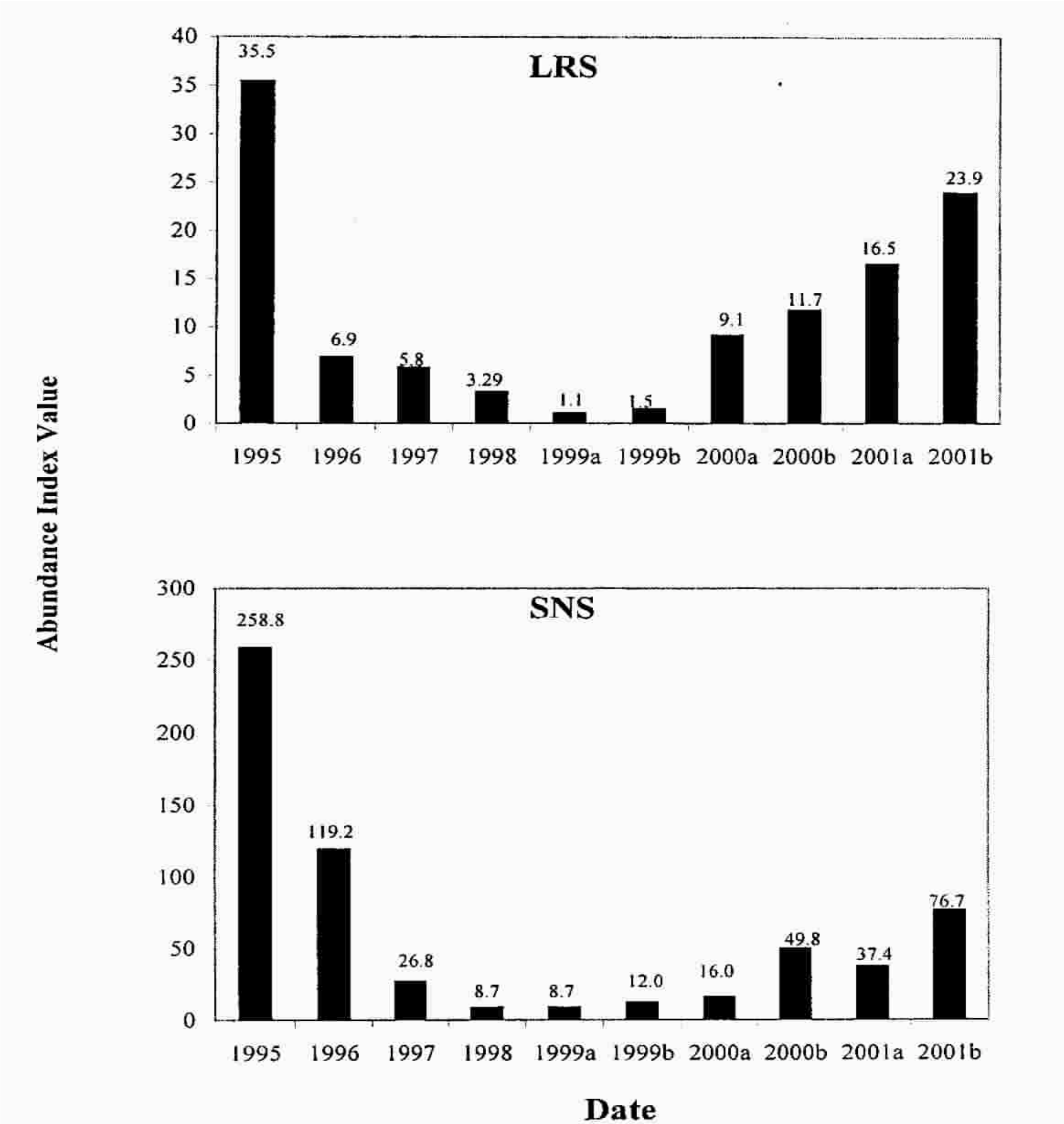
There was little correlation between adult spawning run indices and larval or juvenile indices from 1995-1999 (Cunningham et al. 2002, Markle et al. 2000b, Simon et al. 2000a). However, there was a relatively good correlation between larval and juvenile beach seine indices (Simon et al. 2000b, Simon and Markle 2001). This suggests that successful spawning and production of a strong juvenile year class may be more dependent on environmental conditions and larval/juvenile mortality than on adult spawning effort. In most years there is almost an order of magnitude decline in age 0 sucker abundance from late July to October. The exact cause of this decline is unknown but increased mortality, habitat shifts, dispersal, adverse water quality, and especially entrainment losses are potential factors (Cooperman and Markle 2001).

Spring catch rates of older juveniles in UKL are consistently low (Simon et al. 2000a,b; Simon and Markle 2001). This trend is disturbing and may suggest that late fall/winter juvenile mortality is high, resulting in little or no survival into the second year, even though larval and juvenile numbers appear substantial in summer and fall samples (Simon and Markle 2001). However, the absence of larger juveniles in catches may be caused by sampling difficulties. Therefore, survival and recruitment of juveniles into the spawning population is better assessed by examination of adult spawning populations.

Upper Klamath Lake : Recruitment to the Adult Spawning Population

Some information on relative abundance changes in the adult spawning population can be obtained from variation in the number of suckers migrating up the Williamson River each spring to spawn, which shows the drastic decline during the three fish die-offs (1995-97) and the hiatus in 1998-1999 before the population began to increase in 2000 (Figure 3.3.1-4; Cunningham et al. 2002). The increase in 2000-2001 spawning index probably represents the recruitment of a single dominant year class over a period of two years, rather than recruitment of two distinct year classes. For LRS that would be the 1991 year class, and for SNS it would probably be the 1993 year class.

Figure 3.3.1-4. Abundance index values for adult LRS and SNS captured in trammel nets in the Williamson River, 1995-2000. Adapted from Draft Cunningham et al. 2002, page 29, and other sources.



Examination of the annual length frequency distribution for a spawning population can indicate the arrival of a new cohort of young adults in a given year. Records of annual adult length distributions are available from the Williamson River spawning run and from UKL east-side, shoreline springs (e.g., Sucker, Silver Building and Ouxy springs).

The spawning run up the Williamson River represents the vast majority of tributary spawning suckers and a large percentage of the adult spawning population in Upper Klamath Lake (Bienz and Ziller 1987; Buettner and Scoppettone 1990; Cunningham et al. 2002; Perkins 1996; Perkins et al. 2000; Janney and Shively 2002). Records are available for 1984-85, 1987-1991 and 1994-2001. They show that there is evidence for substantial recruitment into the Williamson spawning populations of each species in only three years over the last eighteen years: 1988, 1995 and 1998. There was also possible minor recruitment in 1992-1993, when there was no sampling, and a small cohort of female LRS entered in 1999. Since the two sucker species and sexes mature at different ages, this represents only three successful year classes, including one from the mid 1980's and only two from the 1990's, apparently 1991 and 1993. The age structure of spawning fish in the Williamson River in 1986 and 1988 indicates that only a single successful cohort entered the spawning population in the period extending from 1975 to 1988 (Buettner and Scoppetone 1990; Scoppetone and Vinyard 1991). That cohort was apparently produced in 1977-1978.

Records of the lake-spawning populations at eastside springs are available for LRS in 1987-1990, 1993 and 1996-2001 (Hayes and Shively 2002b; Perkins et al. 2000). SNS are rarely caught at the springs and records are too limited to draw conclusions. Data show that there is substantial recruitment into the shoreline spawning populations of LRS for only two male cohorts, which entered about 1993 and 1997/98, over the last fifteen years. This suggests that the two successful male year classes, were produced in about 1988 and 1991, or possibly 1993. The only notable female cohort entered in 1997 and may represent the 1991 year class. The size-frequency data show no evidence for a female 1993 year class, which would have recruited in 2000-2001.

Age distribution data are available based on suckers recovered fish die-off events during 1995 (USBR 1996c), 1996 (Perkins 1996) and 1997 (Shively 2002b). These data showed that 95% of the suckers were age 7 years or younger, with most age 4 (1991 year-class) and 5 (1990 year-class). Examination of about 860 suckers from the 1996 fish kill documented LRS and SNS that were mostly 2-8 years old (USGS, unpub. data). Eighteen year-classes of LRS and 11 year-classes of SNS were identified. The most abundant year-class of both species was 1991; the 1988-1993 year classes were also fairly well represented. In 1997, older LRS and SNS were dominant in the die-off.

Preliminary data from adult suckers collected during 2001 indicated that the current total population of LRS in Upper Klamath Lake is dominated by fish 45-65 cm in length, which represent the 1988-1994 year classes exclusively (Coen et al. 2002; USGS 2002, unpub. data). The current population of SNS contains fish 36-55 cm, which represents the 1989-1996 year classes. The dominant year class for LRS is 1991, while the dominant class for SNS is now 1993.

3.3.2 Status: Clear Lake

Sucker populations in Clear Lake exhibit a broad range of sizes, indicative of a diverse age structure. However, LRS in particular are generally dominated by younger individuals, suggesting good recruitment but relatively low adult survivorship (Buettner 1990; Buettner and Scoppettone 1993; CDFG 1993; Shively 2002c). Drought conditions severely reduced sucker habitat in the Clear Lake watershed in the early 1990s. The reservoir reached its lowest level since 1935 and only 5% of the water remained, and many tributaries went dry (USFWS 1994b).

Populations of suckers in small reservoirs above Clear Lake were apparently eliminated, but may have reestablished themselves. Within Clear Lake itself, the sucker population showed signs of stress and reduced condition during the drought, due to adverse temperatures, turbidity and DO conditions at low water levels, but had apparently recovered by the next year. Clear Lake contains large populations of introduced warm-water predatory fishes; their specific impacts on the sucker population are not known. No population estimates are available for the Clear Lake LRS and SNS populations.

The Clear Lake sucker populations are currently isolated from suckers in the rest of the Klamath Basin by Clear Lake Dam, which provides no fish passage. This isolation prevents genetic exchange with other populations and provides no opportunity for natural recolonization of the sub-basin in the event of local extirpation. While suckers are entrained at the dam, this will be reduced by screening in place by May 2002. Generally the populations of SNS and LRS in the Clear Lake sub-basin appear to be relatively healthy, and the primary threat to their persistence would be prolonged drought conditions and perhaps adverse water quality during prolonged ice-cover.

3.3.3 Status : Gerber Reservoir

Monitoring since 1992 within the Gerber watershed has documented a SNS population exhibiting a wide range of size classes (USBR unpub. data). Suckers ranged from 2-14 years old, indicating a young population in the reservoir. The presence of smaller suckers indicates the population in Gerber Reservoir has successfully recruited recently. In dry years, tributaries dry up and fish in Gerber Reservoir are subjected to extremely low water levels, high turbidity, and low DO which may contribute to poor sucker condition in these years. Gerber Reservoir contains large populations of introduced warmwater predatory fishes; their specific impacts on the SNS population are unknown. No population estimates are available for the Gerber SNS population.

The Gerber SNS population is currently isolated from the rest of the Klamath Basin by Gerber Dam, which provides no fish passage. This isolation prevents genetic exchange with other populations and provides no opportunity for natural recolonization of the sub-basin in the event of local extirpation. While some suckers are entrained at the dam, this has been largely eliminated through placement of net screens at the outlet. Generally the population of SNS in Gerber Reservoir appears to be relatively healthy, and the primary threat to its persistence would be prolonged drought conditions and associated adverse water quality.

3.3.4 Status : Lost River

The Lost River currently supports an apparently small population of SNS and very few LRS. Suckers, primarily SNS and Klamath largescale sucker (KLS, *Catostomus snyderi*) have been reported from throughout the drainage (Koch and Contreras 1973; Buettner and Scoppettone 1991; Shively et al. 2000b). However, the majority of both adults and juveniles are caught in a very restricted reach of the river, above Harpold Dam and to a lesser extent from Wilson Reservoir (Shively et al. 2000b). Movement of suckers within the river are severely restricted due to diversion dams, and available habitat is limited by adverse water quality in the impoundments and channelized sections of the river. The Lost River contains large populations of introduced warm-water predatory fishes and has become dominated by introduced fathead minnows; their specific impacts on the sucker population are not known. No population estimates are available for the Lost River sucker populations.

Sucker spawning habitat in the Lost River is very limited. Sucker spawning has been documented below Anderson-Rose Dam, in Big Springs, and at the terminal end of the West Canal as it spills into the Lost River. According to residents, sucker spawning at Big Springs is now rare, but historically it was an important spawning site and was used by Native Americans as a major fishing site during the spawning migration (Klamath Echos). Suspected spawning areas that have suitable habitat (rocky riffle areas) include the spillway area below Malone Reservoir, just upstream of Keller Bridge, just below Big Springs, just below Harpold Dam, and adjacent to Station 48. Spawning has also been documented in Miller Creek, and is suspected in Buck Creek and Rocky Canyon Creeks (Shively et al. 2000b). Based on length frequency distributions it appears that several year classes of SNS are represented within the Lost River.

Populations of both LRS and SNS in historical Tule Lake migrated up the Lost River to spawn at Big Springs (River Mile 42), near Bonanza, Oregon and probably at other shallow riffle areas with appropriate spawning substrate (Coots 1965; Klamath County 1976). The construction of Lost River Diversion Dam in 1912 by Reclamation restricted sucker migrations out of Tule Lake to the lower 23 miles of the Lost River. In 1921, construction of the Anderson-Rose Diversion Dam further restricted migrations to the lower 7 miles of the river. Reclamation has monitored endangered sucker spawning runs from Tule Lake into the Lost River regularly since 1991 (USBR 1998c). Although dozens of suckers were observed spawning during May, and some eggs were found, substantial numbers of larval suckers were only observed in 1995. In 1999, Reclamation changed operations in the Lost River below Anderson Rose Dam, and suckers began migrating to the dam as early as two days after releases were started.

3.3.5 <u>Status: Tule Lake</u>

Historically Tule Lake had enormous sucker populations of both LRS and SNS which made significant spawning runs up the Lost River (Cope 1879; Coots 1965; Howe 1968). Sucker runs up the Lost River were once so large that several canneries were set up to can and process suckers into dried fish, oil, and other products (Howe 1968; Andreasen 1975). Perhaps the largest recorded osprey colony, which numbered about 500 nests, was located near Merrill, Oregon, and was probably dependent on suckers and other fishes from Tule Lake (Henny 1988). The vast sucker populations that migrated out of Tule Lake are severely reduced today. The lake was sampled for suckers in 1973, but none were collected (Koch and Contreras 1973). However, in 1991 both species were observed spawning below Anderson-Rose Dam, and in 1992-93 about 20 specimens of each species were captured in Tule Lake (Service 1993a). Further sampling has confirmed a small population of both species in the Tule Lake sumps (Scoppettone, Shea, and Buettner 1995). The negative surveys of Koch and Contreras are likely explained by limited collecting effort in areas where suckers aggregate and low sucker population levels. It seems unlikely that suckers have only recently re-invaded the sumps via entrainment of fish into irrigation canals. Suckers inhabiting Tule Lake, while low in number, were found to have a high condition factor (ratio of weight to length) relative to that of other Klamath Basin sucker populations.

Population estimates, based on limited capture and recapture data, estimate 159 adult SNS (95% CI: 48-289) and 105 LRS (95% CI: 25-175) in the Tule Lake populations, which contain few size classes (Scoppettone, Shea, and Buettner 1995). Most SNS are about 46 cm FL, and most LRS are 46-60 cm FL. While an accurate estimate of the population size is not possible, the available information suggests that sucker population sizes in what remains of the lowest reach of the Lost River and Tule Lake are currently limited to a few hundred individuals of each species.

Sucker habitat in Tule Lake sumps for juveniles and adults is extremely limited due to shallow depths, and the sumps continue to fill with sediment. Approximately 8,000 and 5,000 acre-ft of storage were lost from sumps 1A and 1B, respectively, between 1958 and 1986 (USBR unpub. data). Wind- and water-borne silt is coming primarily from agriculture in the Lost River watershed (Service 1998c). Since the Tule Lake sumps are shallow, with an average depth of less than 4 ft, this loss of habitat is significant. Reduction of water depth in Tule Lake is a threat to the suckers because it increases the risk of a winter freeze, reduces the amount of deepwater habitat for adult suckers, increases avian predation, and may contribute to poor water quality by allowing the water to heat more rapidly and allowing sediments and nutrients to be more readily mixed by wind shear. The Refuges are developing a plan of sump rotation that may help alleviate the problem of siltation in Tule Lake, however, sediment transported by the Lost River will continue to be a problem until erosion in the Lost River watershed is reduced.

Rearing habitat in the Lost River downstream of Anderson-Rose Dam is limited both by water quality and structural features of the channelized river. The lower Lost River is, at high lake levels, made up almost entirely of backed-up sump water, and water quality conditions reflect those in the sump. A few small irrigation return drains empty into the river in this reach and may contribute to water quality degradation.

The small sucker populations residing in what remains of Tule Lake are likely limited by a lack of recruitment, inadequate water depth, and seasonally poor water quality. Other than Clear Lake and UKL, Tule Lake (including a portion of the Lost River) contains the only additional population of LRS within its historical range. The small Tule Lake populations of both species appear to be healthy, relatively free of parasites and skin infections, and to have a higher condition factor than suckers found elsewhere in the Basin. However, present rates of sedimentation threaten the persistence of their remaining habitat.

3.3.6 Status: Lower Klamath Lake

Prior to 1917, Lower Klamath Lake was seasonally connected to the Klamath River either when it flooded in spring or later in the summer when the river level was down and water flowed from the lake to the Klamath River (Weddell 2000). Steamboats were even able to navigate the Klamath Straits, a slough that connected the lake and river. The railroad completely severed that connection by 1917, and by 1924, the majority of the Lower Klamath wetlands had been drained (Weddell et al. 1998; Weddell 2000). Connectivity between Lower Klamath Lake and the rest of the Klamath Basin is now limited to water pumped through Sheepy Ridge from Tule Lake and various irrigation channels that connect into the Keno impoundment, primarily the Klamath Straits Drain and Ady Canal.

Prior to about 1924, suckers migrated up Sheepy Creek (a spring-fed tributary to Lower Klamath Lake) in sufficient numbers that they were taken for food or to feed hogs (Coots 1965). In 1960, small numbers of adult suckers were observed moving up Sheepy Creek in the springtime (Coots 1965). Since 1960, available survey information, though limited, indicates no suckers remain in Lower Klamath Lake sub-basin (Buettner and Scoppettone 1991; Koch and Contreras 1973; Maria, California Dept. Fish and Game, pers. comm. 2001). Occasional suckers may disperse into the Lower Klamath Lake sub-basin through irrigation canals, but there is apparently no suitable habitat for long-term survival, and at present there are no known resident populations in the Lower Klamath Lake sub-basin.

3.3.7 Status: Link River

Prior to construction of the Link River Dam, there were apparently large spawning runs of suckers migrating up the Link River in March, which were described as "immense congregations" of fish weighing two to six pounds (Klamath Republican 1901). The origin of these runs is not recorded; presumably, they came up out of Lower Klamath Lake or the Lake Ewauna/Keno reach, as no suitable lake habitat was not available below Keno prior to construction of J.C. Boyle Dam. Suckers apparently occupied the Link River even in summer, as evidenced by accounts of stranded "mullet," when flow to the Link River was cutoff by southerly winds producing a seiche (a wind-drive oscillation of the water surface) in UKL that lowered the level at the outlet to below the sill and the river temporarily stopped flowing (Spindor 1996).

There has been no concerted effort to survey the Link River itself for fish distribution and seasonal use patterns. However, the limited information available demonstrates that adult suckers still make an attempt to migrate upstream in the Link River during the spring, and at least juveniles apparently reside in the river below the dam throughout most of the year. Primarily juvenile suckers are consistently caught during salvage operations conducted at the base of the Link River Dam during maintenance operations and spill termination, which occurs in most seasons except the January-March period (USBR 2000). Small numbers of adult suckers have also been found attempting to utilize the poorly designed fish ladder at the Link River Dam (Fortune unpub. data; Hemmingsen et al. 1992; PacificCorp 1997; Schrier, PacificCorp, pers. com. cited in USBR 2001).

While suckers appear to still occupy habitat throughout the Link River in low numbers, the lower Link River is probably crucial to suckers and other fish, since it may be the best habitat now available in the reach upstream of Keno. The lower Link River can serve as a critical refuge for fish during periods of low DO. Water quality in Lake Ewauna is frequently very poor and the higher water quality in the Link River may allow fish from the lake to survive. Link River, because of its high gradient and numerous cascades, has a significant potential for oxygenation of water prior to entry into Lake Ewauna where there is a high biochemical oxygen demand. Furthermore, a number of small springs along and in the channel add fresh, high-quality water to the river. In summer, when most of the flow is diverted into the hydroproject, water quality in the Link River itself and the reach's potential to oxygenate water entering Lake Ewauna is greatly compromised by the reduced flow caused by the diversions.

At this time, suckers attempting to move up into UKL, including those that have been entrained from UKL and delivered downstream by diversion channels, are effectively prevented by the Link River Dam. Mature suckers trapped below the Link River Dam are prevented from reaching spawning grounds in UKL or its tributaries and are lost to the population.

3.3.8 Status: Keno Impoundment (Lake Ewauna to Keno Dam)

Historically, Lake Ewauna and the upper Klamath River were connected to both the Lost River, at least in years of high water, and to Lower Klamath Lake. In 1890, the paddle-wheeler "Mayflower" was able to navigate up the Lost River Slough and moved down the Lost River to near Merrill. The Lake Ewauna/ upper Klamath River reach may have formed a critical connectivity corridor for suckers moving between the Upper and Lower Klamath lakes and the Lost River. Currently, Lake Ewauna and the upper reach of the Klamath River above the Keno Dam form an impoundment 20 miles-long by 300 to 2600 ft-wide, with depths of 9 to 20 ft (the Keno Impoundment, see Environmental Baseline). Water quality in this reach of the Klamath River is seasonally poor and it is 303(d)-listed by Oregon Department of Water Quality for DO, pH, Chl-a, and ammonia (CH2M Hill 1995; ODEQ 1998).

Very little is known about the present use of the Keno to Link River reach by suckers or other fishes, and no systematic sampling has been done. There is evidence that some suckers still migrate upstream past the Keno Dam (Hemmingsen et al. 1992; ODFW 1996; PacifiCorp 1997). Their destination and success at reaching it are unknown. The occasional capture of adult suckers in the Keno Impoundment, the presence of suckers both in the Link River itself and at both the Link River and Keno fish ladders, and the apparent out-migration of tens of thousands of juveniles from UKL in the late summer and fall demonstrate that suckers utilize this reach and suggests that improvement of habitat quality, coupled with adequate fish passage at the Link River and Keno Dams, would be a key component to restoring exchange between UKL and downstream populations, as well as allowing the survival and return of the large number of suckers swept downstream of the Link River Dam from UKL.

3.3.9 Status: Klamath River Reservoirs

Downstream of Keno Dam the Klamath River consists of three primary reservoirs (J.C. Boyle, Copco and Iron Gate) interconnected by three riverine reaches (Desjardins and Markle 2000, Fishpro 2000). Four species of suckers are known from the Klamath River and its reservoirs: LRS, SNS, KLS, and the Klamath smallscale sucker (KSS, *Catostomus rimiculus*). The KSS is principally a river- and stream-dwelling species which is rare in the upper Basin. Due to the high-energy character of the river reaches, the primarily lake-dwelling LRS and SNS are not expected to occupy them, except potentially for spawning and as migration corridors. Of the five dams below UKL, only Keno and J.C. Boyle have fish passage facilities. While the Keno and J.C. Boyle ladders are apparently passable by suckers to some degree, neither is designed for optimum sucker passage.

The SNS is the only lake sucker that occurs in abundance in the Klamath drainage below Keno, and adult SNS have been consistently collected in all three reservoirs (J.C. Boyle, Copco, and Iron Gate). Copco Reservoir apparently contains the largest population of larger adults.

However, the two lower reservoirs, Copco and Iron Gate Reservoirs contain few sub-adults, which are generally present only in J.C. Boyle Reservoir. Although larval suckers have been caught in all three reservoirs, their identity is uncertain. SNS spawning behavior has been recorded from Copco, but there is no evidence that SNS consistently survive past their first year in the reservoir (Beak Consultants 1987; Buettner and Scoppettone 1991; Desjardins and Markle 2000).

LRS are apparently rare in the two upper reservoirs and have not been recorded from Iron Gate. In 1956, Coots did catch three LRS in Copco, however it is unclear whether they were abundant at the time (Coots 1965); more recent surveys have caught only a few individuals (Desjardins and Markle 2000). ODFW and PacifiCorp caught only eight LRS passing the Keno Dam from 1988-1991 (ODFW unpub. data, PacifiCorp 1997).

Desjardins and Markle (2000) considered J.C. Boyle to be a possible sink for UKL larvae and juvenile suckers entrained into the Klamath River from UKL. J.C. Boyle was the only reservoir where juveniles were plentiful. No SNS or LRS have been recorded spawning in J.C. Boyle.

3.4 Life History

This section provides a brief review of the life history of the two suckers relevant to formulating this BO. Greater detail is available in Appendix D.

LRS and SNS are both large, long-lived, lake-dwelling fish that are found only in the Klamath Basin above Iron Gate Dam. Adult LRS can reach 39 inches in length, while SNS are generally less than 20 inches. LRS naturally live over 43 years, and SNS can live at least 33 years (Scoppettone 1988). Larvae reach about an inch (25-30 mm) in length by July. They are generally considered as young-of-the-year juveniles above that size (Buettner and Scoppettone 1990, Simon and Markle 2001). By October of their first year juveniles reach about 2 - 4 in (5-10 cm). Male LRS begin to enter the spawning population at about age 4 and a size of about 16 in. Female LRS begin to spawn at about age 7 and a size of about 20 in. (Buettner and Scoppettone 1990; Perkins et al. 2000a). Male and female SNS begin to spawn at about age 4-5 when they reach a length of about 11-13 in.

3.4.1 Reproduction

Klamath suckers can be separated into three groups, based on where they spawn. Adult SNS and LRS primarily occupy lake habitats, of these some migrate into tributaries to spawn, while others spawn in suitable near-shore lake habitats, primarily springs. There are also apparently some SNS that both live and spawn in streams, notably in the Clear Lake and Gerber Reservoirs. Stream and lake spawning populations appear to rarely exchange individuals and appear to be reproductively isolated (Perkins et al. 2000a; Shively et al. 2000a; Hayes and Shively 2001).

Currently, most of the stream-spawning LRS and SNS in UKL move up the Williamson and Sprague River to spawn. Small spawning populations of LRS and SNS may also utilize the Wood River (Markle and Simon 1993; Simon and Markle 1997). Both LRS and SNS also spawn at shoreline sites within UKL, especially at eastside springs and areas with a gravel substrate

(Buettner and Scopettone 1990). Along the eastern shore of UKL known spawning occurs at Sucker, Silver Building, Ouxy, and Boulder springs, and Cinder Flats (Shively et al.2000; Hayes and Shively 2001). Suckers in the Clear Lake and Gerber Reservoir drainages spawn primarily, if not entirely, in the tributary streams (Buettner and Scoppettone 1991; Koch and Contreras 1973; Perkins and Scoppettone 1996; USBLM 2000).

Spawning generally occurs from February - June and peaks between mid-April and early May. The timing of spawning migration is somewhat variable from year to year and is apparently dependent on age, species, sex, and environmental conditions (Andreasen 1975; Buettner and Scoppettone 1990; Hayes and Shively 2001; Klamath Tribes 1996; Markle 1993; Markle et al. 2000b; Perkins et al. 1997, 2000a; Perkins and Scoppettone1996; Shively et al.2000; USBLM 2000; Ziller 1985). Larger suckers and males appear to migrate earlier than smaller ones and females. LRS tend to spawn earlier than SNS.

LRS and SNS typically spawn at night in shallow areas with gravel substrate where eggs are broadcast or slightly buried (Bienz and Ziller 1987; Buettner and Scoppettone 1990, 1991; Klamath Tribes 1995; Perkins and Scoppettone 1996; Perkins et al. 2000a). Water depth for most spawning sites ranges from about 1-4 ft.

In a single spawning season, a single LRS or SNS female can produce 18,000-72,000, and 44,000-236,000 eggs, respectively (Perkins et al 2000a). Larger, older females produce substantially more eggs and therefore can contribute relatively more to recruitment than a recently matured female. However, probably only about 1-10% of the eggs survive to become larvae.

3.4.2 <u>Larvae (less than 1 inch)</u>

Soon after hatching, sucker larvae move out of the gravel; they are about a third of an inch (7-9 mm) long and mostly transparent with a small yolk sac (Buettner and Scoppettone 1990). Larval suckers need to begin feeding quickly, before they exhaust their yolk or they starve (Cooperman and Markle 2000; Klamath Tribes 1996). The availability of appropriate habitat, which provides sufficient food soon after hatching, is critical to the survival of larvae.

Larvae apparently spend relatively little time upriver before drifting downstream to the lakes (Buettner and Scoppettone 1990; Cooperman and Markle 2000; Klamath Tribes 1996; Markle et al. 2000b; Perkins and Scoppettone 1996). In the Williamson River, larval sucker out-migration from spawning sites can begin in May and is generally completed by mid-July. Downstream movement takes place at night and near the water surface. During the day, larvae appear to move to the rive margins and to seek cover in the emergent shoreline vegetation.

In UKL, larval suckers are first captured in early April during most years, with peak catches occurring in June, and densities dropping to very low levels by late July (Cooperman and Markle 2000, Simon et al., 1996, 2000a). Larval suckers are found throughout UKL, with highest concentrations generally at the mouth of the Williamson River and just to the east and west of the mouth, apparently depending on flow patterns. At the Link River, larval suckers have been collected as early as April 28 and as late as July 18 (Gutermuth et al. 1999).

Larval habitat in UKL is generally along the shoreline, in water 4 - 20 in deep and associated with emergent aquatic vegetation, such as bulrush (Buettner and Scoppettone 1990; Cooperman 2002; Cooperman and Markle 2000; Dunsmoor 1993; Dunsmoor et al. 2000; Klamath Tribes 1995; 1996; Markle and Simon 1993; 1994; Reiser et al. 2001; Simon et al. 1995, 1996). Emergent vegetation provides cover from predators (especially fathead minnows), protection from currents and turbulence, and abundant prey (including zooplankton, macroinvertebrates, and periphyton). Larvae appear to avoid areas without emergent vegetation. Larvae also do not use submerged vegetation (e.g., pondweeds) as an alternative to emergent vegetation (Cooperman 2002). This is apparently due to habitat preferences of the larvae and due to the absence of submerged vegetation, which die back in the winter and do not reappear until mid summer, when larvae are transforming into juveniles.

Larval sucker ecology and habitat use in Clear Lake and Gerber Reservoirs is unstudied at present. Permanent emergent vegetation is generally scarce or absent along the reservoir shorelines. However, some vegetative cover may be provided by flooded annual grasses and herbs remaining from the previous growth season prior to lake level rising in the spring. Additional cover may be provided by high turbidity, and larvae may utilize shallow shoreline areas to avoid predators. The lower reaches of the primary spawning tributaries do provide emergent shoreline vegetation and extensive submerged vegetation during the spring and early summer when larvae would be present.

Larvae transform into the juveniles at about an inch in length (25-30 mm). This generally occurs by the end of July.

3.4.3 First Year Juveniles (1 - 4 inches in length)

Juvenile sucker habitat is generally in nearshore areas less than 4 ft in depth (Markle and Simon 1993; Reiser et al. 2001; Simon et al. 2000b; Simon and Markle 2001; VanderKooi 2002; Vincent 1968). Juveniles in unvegetated habitats occur primarily over rocky substrates (rock, gravel, and gravel and sand mix) and appear to avoid sandy and softer muddy bottoms. Recent evidence suggests that emergent vegetation also provides important habitat for juvenile suckers (Reiser et al. 2001; VanderKooi 2002). Rocky bottoms occur along the shoreline primarily in the southern portion of UKL while emergent shoreline vegetation occurs primarily in the northern half of the lake, and soft, mucky bottoms occupy the vast majority of the deeper offshore areas.

In mid-summer, juveniles are concentrated in the northern and eastern sections of UKL, near the the mouth of the Williamson River and along the eastern shoreline. In late summer and fall most juveniles are concentrated in the south end of UKL and along the eastern shoreline (Simon et al. 2000b; Simon and Markle 2001; Simon, unpub.data 2002).

Juvenile sucker abundance drops dramatically from late July to October in UKL (Simon and Markle 2001; Simon, unpub. data 2002). Catches of juveniles in emergent vegetation also declined significantly near the end of August in both 2000 and 2001, coinciding with lake levels dropping below 4140 ft (VanderKooi 2002). Near 4140 ft, vegetated *Scirpus* habitat becomes increasingly unavailable as water level drops, and at 4140 ft is essentially unavailable (Reiser et al. 2001). The late summer declines in juvenile abundance are associated with substantially increased entrainment of juveniles into the A-canal and Link River diversion channels during the same period (Gutermuth et al.1999, 2000a, 2000b). It is currently uncertain as to whether the increased entrainment is due to a juvenile migration out of the lake or by concentration of juveniles in habitat provided by the south end of UKL after dropping lake levels have reduced available shoreline habitat in the north.

3.4.4 Adults (over at least 10 inches) and sub-adults (over 4 inches)

Adult LRS are generally limited to lake habitats when not spawning, and no large populations are known to occupy stream habitats. SNS, on the other hand, have resident populations in both lake and some riverine habitats, including: Lost River, Miller Creek, Willow Creek, and other tributaries of Clear Lake and Gerber Reservoir.

Cover is a primary habitat feature required by fish. For fish like lake suckers that primarily occupy open water, depth and turbidity provide needed cover. In streams, while deeper pools provide some cover, additional cover is provided by instream and overhanging structure (Buettner and Scoppettone 1991; Perkins and Scoppettone 1996). Adults, and probably subadults, of both species are bottom-oriented, consistently staying within 1 ft of the bottom (Buettner and Scoppettone 1991; Reiser et al. 2001; USBR 2000d). Adults rarely enter water shallower than 3 ft, except to spawn at night, and show a strong preference for water deeper than 4 feet (USBR 2000d; Reiser et al. 2001). In Tule Lake, where most habitat is shallower than three feet, adult suckers are found only in the very limited areas with available habitat over 3 ft in depth (Hicks et al. 2000; USBR 2000c).

In the summer and fall, adult suckers generally occupy the northern third of UKL (Bienz and Ziller 1987; Buettner and Scoppettone 1990; Golden 1969; Perkins 1996; Perkins et al. 2000b; Reiser et al. 2001; Simon 2000a; USBR 1996a, 2000d). However, suckers apparently avoid shallow, clear water in UKL except when showing ill effects of poor water quality (Bienz and Ziller 1987; Buettner and Scoppettone 1990; USBR 1996a). Avoidance of shallow depths by adult suckers may be related to increased vulnerability to predators, including pelicans, osprey, bald eagles, and man. The need to seek adequate depth in UKL may make suckers more vulnerable to the adverse effects of poor water quality because they appear to avoid inflow areas where the water quality is high, but there is a lack of cover owing to shallow depths and relatively high water clarity, and appear to remain in deeper where water quality is frequently worse.

4.0 ENVIRONMENTAL BASELINE FOR THE SHORTNOSE AND LOST RIVER SUCKERS

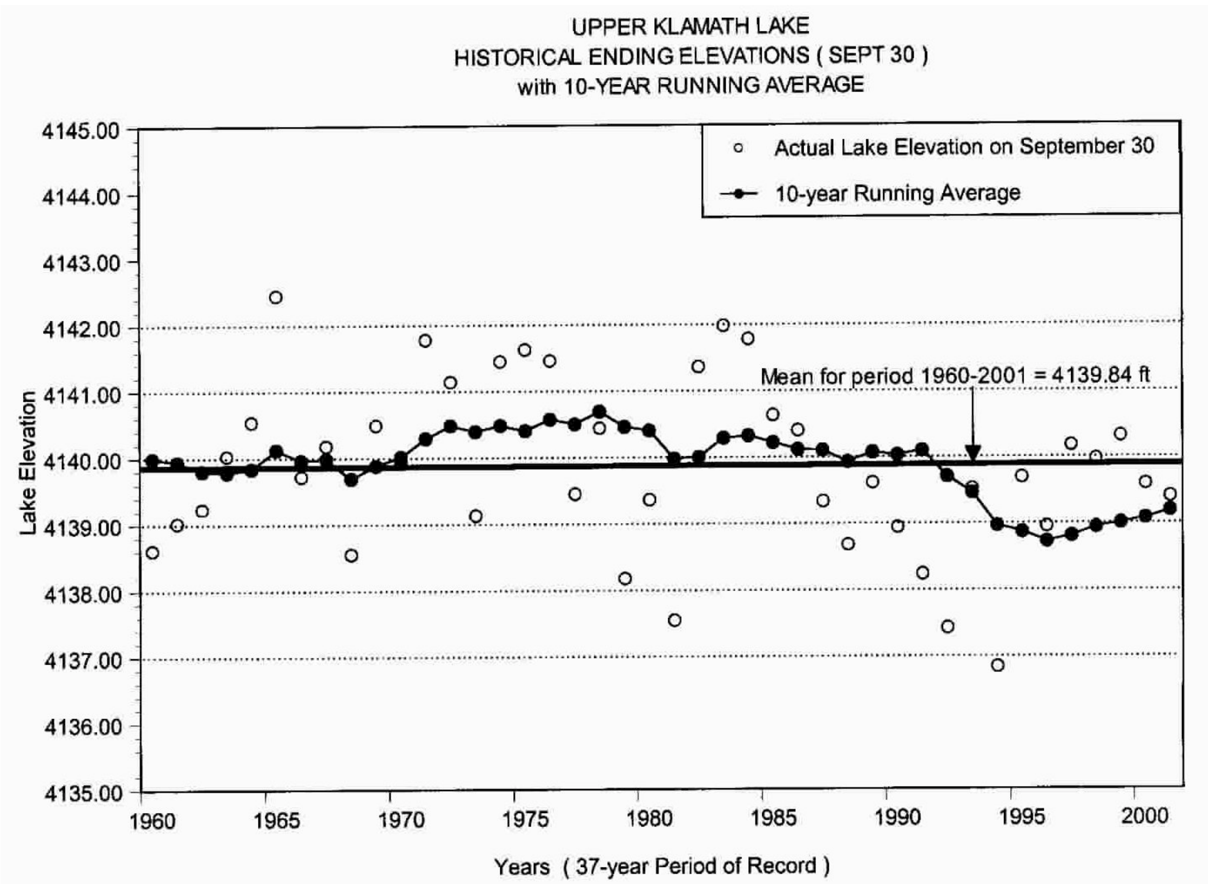
This section presents an analysis of the effects of past and present human and natural factors that have led to the current the status of the LRS and SNS within the action area, including habitat/ecosystem conditions. It is a “snapshot” of the current status of the suckers but does not include effects of the proposed action that are described later in this opinion.

UKL (including Agency Lake), with a surface area ranging from 60,000 to 90,000 acres depending on lake levels, is currently the largest water body in the Klamath basin. Historically the lake had a surface area of about 111,500 acres, if the 34,140 acres of diked and drained wetlands are added to the present surface area (Geiger 2001). Mean summer depth is now about 8 feet (at 4141.3 ft).

Regulation of water levels in UKL began in 1919, with completion of the Link River Dam (Boyle 1987). By 1921, the reef at the entrance to Link River was lowered (Figure 4.0-2). Prior to construction of the dam and channelization of the reef, measured lake levels varied from about 4140 to 4143 ft., with a mean annual variation of about two ft (Boyle 1987, USBR data). According to Boyle (1976, 1987) the pre-dam minimum elevation of UKL was 4140.0 ft in September 1908, and the high was 4143.3 ft on April 1907; average annual variation was about 2 feet. It should be noted that during the historic period of record precipitation levels were above average and thus lake levels may have been higher than normal.

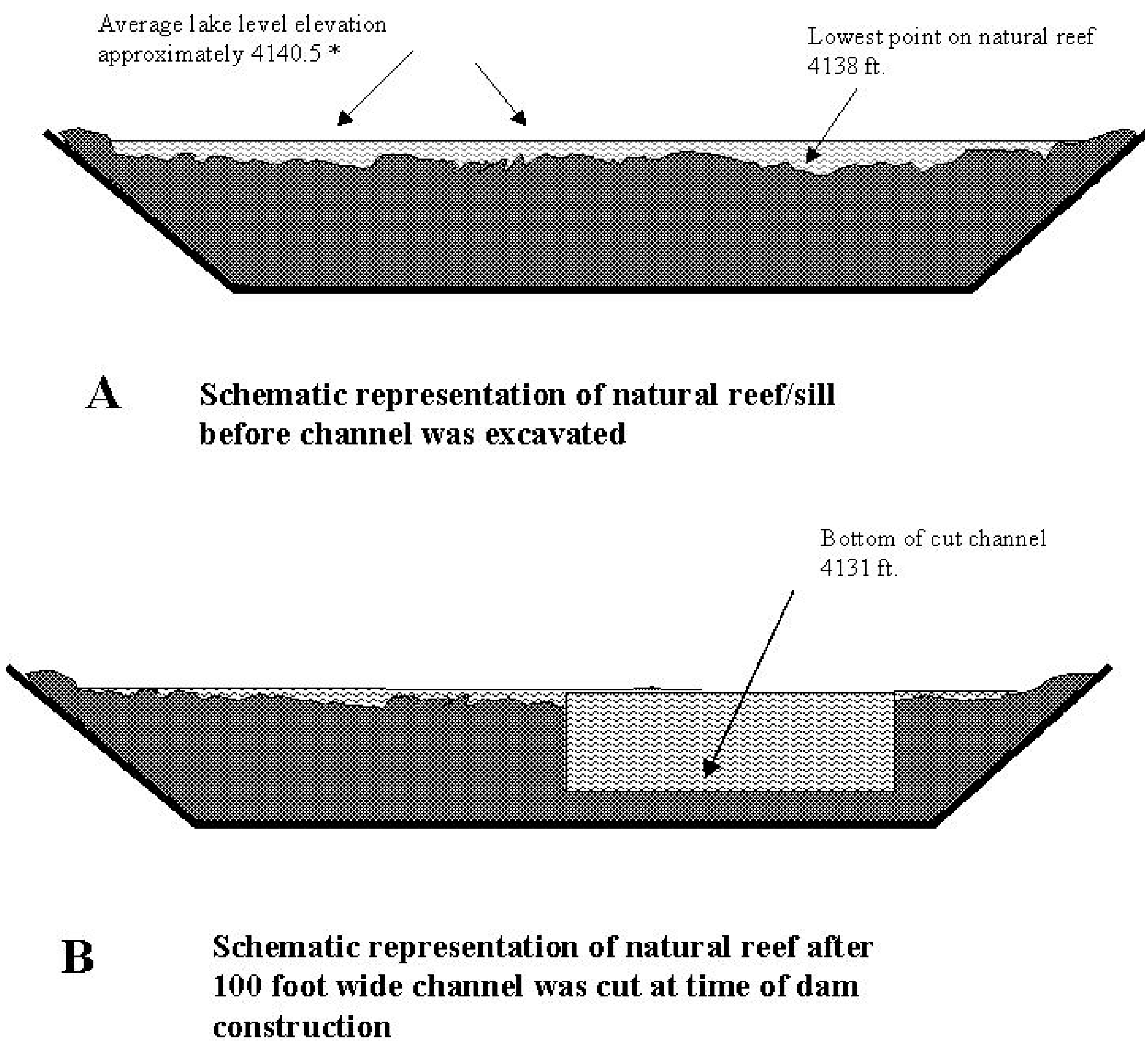
Since 1921, water levels in UKL have varied from 4136.8 to 4143.3 ft., with a mean September 30 lake elevation of 4139.84 ft. during the period of historic record from 1960-2001 (USBR data; Figure 4.0-1).

Figure 4.0-1. Upper Klamath Lake: Historic September 30th lake elevations for the period 1960-2001.



Water level regulation has also changed the seasonal timing of high and low elevation by making the highest and lowest elevations occur earlier in the season as well as prolonging the period of low water. This likely has had profound effects on the ecology of the lake, as described below. For additional information and more discussion on this topic see Appendix E.

Figure 4.0-2. Schematic representation of the natural reef of Upper Klamath Lake and the relationship between the channel and lake level. (Diagram is not to scale)



* The natural reef was a long, wide sloping sill (not like the vertical wall of a dam). The depth of the water passing over it was directly related to inflows. The average end-of-summer lake elevation was approximately 4140.5 ft. and the lake did not drop lower than the sill elevation of 4138 ft.

4.1 Water Quality

4.1.1 Upper Klamath Lake

Water quality has a profound effect on sucker survival. This section summarizes water quality information for the lake that is relevant to the LRS and the SNS. Because of the importance of water quality as a factor affecting sucker survival, the reader is encouraged to review Appendix D for a more detailed analysis of water quality information.

The highly productive condition known as hypereutrophication, which creates seasonally adverse water quality in affected water bodies, is well documented to occur at UKL (U.S. Army Corps of Engineers [USACE] 1982; Kann and Smith 1993; Kann 1993a,b; Martin and Saiki 1999; Perkins et al. 2000b; Welch and Burke 2001; Walker 2001; ODEQ 2001). Hypereutrophic conditions enable extensive blooms of the blue-green alga (cyanobacterium) *Aphanizomenon flos-aquae* (*AFA*) to develop in UKL. These blooms cause significant water quality deterioration due to: elevated pH (Kann and Smith 1993); both supersaturated and low (hypoxic) DO concentrations; and elevated levels of un-ionized ammonia, which can be toxic to fish (Perkins et al. 2000b; Welch and Burke 2001**;** Walker 2001). *AFA* blooms reach such dense concentrations in UKL that the water turns pea-green in color during the summer and fall. As a result, acutely toxic, chronic, and stressful conditions for suckers and other fishes likely occur at some scale on an annual basis in the lake.

The Klamath Tribes and Reclamation have been intensively monitoring spring and fall, limnological conditions in UKL since 1990, using biweekly samples of key parameters to document temporal and spatial variability in water quality, nutrients, and *AFA* biomass. Several reports have been completed that analyze this information (e.g., Kann 1993a, b; Kann and Smith 1993; Klamath Tribes 1995; Jassby and Goldman 1995; Wood et al. 1996; Kann and Smith 1999; Kann 1998; Welch and Burke 2001; Loftus 2001; Walker 2001; ODEQ 2001).

Effects of *Aphanizomenon flos-aquae* on Upper Klamath Lake Water Quality

The relationship between *AFA*-induced water quality changes and fish growth and survival in hypereutrophic lakes, and how that relationship could be affected by lake depth is important with respect to UKL because water quality has such a profound effect on the suckers and the entire lake ecosystem (Perkins et al. 2000b; Loftus 2001; Reiser et al. 2001; Welch and Burke 2001).

High nutrient loading promotes correspondingly high production of algae and *AFA*, which, in turn, modifies water quality characteristics that can directly diminish the survival and reproduction of fish populations. The following chain of causal relationships and mechanisms, which is supported by the scientific literature, is characteristic of hypereutrophic lake systems and is likely occurring in UKL.

AFA + Nutrients + Light →*AFA* Growth→Water Quality→Fish Survival

Under conditions of high nutrient input and adequate light, *AFA* biomass increases until light, temperature, nutrients, grazers, or other factors limit further growth. As biomass increases, the available soluble forms of nitrogen (N) and phosphorus (P) decrease, because the nutrients are accumulated in the *AFA* biomass, and are therefore unavailable for further biomass increase. The nutrient in shortest supply, relative to growth requirements, at a given time is the limiting nutrient. Because *AFA* can fix atmospheric nitrogen, its growth is not considered limited by nitrogen concentrations (Reynolds 1986); however, this does not necessarily mean that if additional nitrogen were available it would not lead to an increase in *AFA* biomass. A total maximum daily load (TMDL) analysis was recently developed for UKL as part of the determination of water quality criteria under the Clean Water Act; that analysis considered the role of nitrogen in the lake, but focused on limiting phosphorus input to improve water quality because nitrogen is more difficult to control and because *AFA* growth is not limited by nitrogen (Walker 2001; ODEQ 2001).

During *AFA* and other phytoplankton blooms, particularly when coupled with high rates of nighttime respiration, DO can vary considerably over a 24-hour period, but more importantly, levels can get sufficiently low to affect fish survival. Following these blooms, when high levels of *AFA* and other phytoplankton biomass begin to senesce and die-off, the respiration of phytoplankton and the microbial degradation of this biomass and additional DO demand by organic-rich sediment can deplete DO and increase ammonia concentrations to levels that likely reduce growth of and are stressful or are lethal to fish.

External Phosphorus Loading

Phosphorus is of particular concern in UKL due to its likely role in controlling *AFA* productivity, which in turn influences water quality conditions affecting fishes, particularly severe DO declines. Cyanobacterial blooms are associated with shallow lakes where phosphorous concentrations exceed 50-100 ug/l (Sas 1989 cited by Walker 2001); phosphorous concentrations >100 ug/l are common in UKL. Parameters that determine phosphorus concentrations in UKL include: inflow concentrations; inflow water volume; internally regenerated phosphorus from sediments (termed internal loading); and lake volume (Welch and Burke 2001; Walker 2001).

Despite high background phosphorus levels in upper Klamath Basin tributaries and springs (Kann and Walker 1999; Rykbost 1999; Walker 2001; ODEQ 2001), data from several studies indicate that phosphorous loading and concentrations in UKL are elevated substantially above these background levels (Miller and Tash 1967; USACE 1982; USBR 1993a, b; USGS 2000; USGS Water Resources Data 1992-1997; Kann and Walker 1999; Welch and Burke 2001; Walker 2001; ODEQ 2001).

Despite high background levels, much of the phosphorus entering UKL appears to originate from anthropogenic activities such as agriculture and forestry. Gearheart et al. (1995) estimated that total phosphorus loading in the UKL watershed is about equally divided between agriculture and forest land uses, being 38% and 36%, respectively. Agriculture has been identified as a major total phosphorus source in the upper Klamath Basin, especially from drained wetlands (Snyder and Morace 1997). Coupled with the considerable, but diffuse, non-point contribution of phosphorus from pumping of drained wetlands, flood-plain grazing, flood irrigation, erosion of uplands, and channel degradation, the total phosphorus input from anthropogenic sources likely accounts for a far greater percentage than that indicated by the 31% contributed due to direct pumping alone.

Total phosphorus concentrations in UKL tributaries are correlated to runoff, suggesting that erosion is the primary causative agent (Gearheart et al. 1995, Williams 1998). Total phosphorus levels are often correlated with turbidity or total suspended solids because phosphorous is often bound to small-sized particles. Total phosphorus loads during the 1992 and 1994 drought years were 62% of the 1992-1998 average. The 1993 water year is of note because while flow was 108% of the 7-year average, total phosphorus load was 114% of the average. Other years (with the exception of 1996) tended to have a percentage of average total phosphorus loads lower than their respective percent of average water inputs. It may be that during several low inflow years (e.g., 1991 and 1992), watershed sources of total phosphorus accumulate, and are then flushed into the lake during the next high flow year. Because the Sprague River watershed is severely impacted by wetland and riparian loss, flood-plain grazing, agricultural and forestry practices, and channel degradation, it would be prone to total phosphorus export, especially during major runoff events.

There is a possible link between elevated levels of total phosphorus as a result of high spring flows, as discussed above, and *AFA* biomass and fish kills. Wood et al. (1996) determined that there was an apparent relation between total phosphorus concentration and lake level during June. Further, total phosphorus concentration was correlated with Chl-a concentration in June, suggesting that the strength of the first bloom is influenced by phosphorus concentration. External phosphorus loading from spring runoff could be an important factor in determining the phosphorus concentration in the lake at that time and may also create conditions leading to a large *AFA* biomass that creates adverse water quality conditions later in the summer.

Wood (2002) noted that 5 of the 6 recorded major fish kills in UKL have been in years with “extreme” spring runoff. Fish kills in 1971, 1986, 1995, 1996, and 1997, were all in years where the spring runoff recurrence intervals ranged from 7 to 20 years (Table 4.1.1-1, below). Sediment loading, with its associated total phosphorus, as discussed above, could play a role in *AFA* bloom dynamics in late spring that are key to adverse water quality later in summer that causes fish die-offs. Although this hypothesis seems reasonable, Wood (2002) cautions that there were fish kills in years of low flows (e.g., 1932) and years of high flows with no fish kills (e.g., 1993 as discussed above), so the relationship is not absolute, but does have reasonable support.

Table 4.1.1-1. Fish die-off years and estimated spring runoff recurrence intervals for UKL (Wood 2002).

Year of Reported Fish Die-off	Estimated Spring Runoff Recurrence Interval into UKL
1932	“Extremely low inflow”
1971	7-year
1986	15-year
1995	7-year
1996	15-year
1997	20-year

A reduction in external phosphorus loading is the only practicable means of improving water quality in UKL. Walker (2001) showed a relationship between increased total phosphorus in UKL and external anthropogenic inputs. He determined that a 30-50% load reduction was necessary to meet water quality criteria established by ODEQ. This 30-50% total phosphorus load reduction “target” has been adopted by ODEQ in their draft TMDL. Walker (2001) points out that this could be achieved since some data show that an 8% decrease in total phosphorus possibly occurred in the past decade, likely as a result of watershed and wetland restoration efforts. However, there is some debate as to whether this is a real trend; more data are needed for corroboration (Kann 2001; Wiltsey 2001). Gearheart et al. (1995) estimated that over 50% of the annual total phosphorus load from the UKL watershed could be reduced with appropriate management practices, and Anderson (1998) likewise estimated that in-lake total phosphorus concentration could be reduced by using watershed management strategies, especially tributary wetland restoration and riparian fencing. Such activities are the focus of many restoration projects as discussed later in this chapter.

Internal Phosphorus Loading

Of the phosphorus entering UKL some is transported downstream and some remains in the lake and becomes what is termed “internal phosphorus.” Nutrient loading studies show that the largest flux of phosphorus available for *AFA* growth in UKL during the summer comes from internal sources (Barbiero and Kann 1994; Laenen and LeTourneau 1996; Kann 1998; Kann and Walker 1999; Welch and Burke 2001; Walker 2001). On average, external loading was 39% of the total loading to the lake, while internal loading was 61 percent.

The total phosphorus load in UKL outflows tends to increase during high runoff events in the winter and spring, as well as during the summer when inflow load is low. It is clear from this trend, and the increase in total phosphorus storage in the lake at a time when lake water storage is decreasing, that total phosphorus is being internally loaded from the sediments (Kann 1998).

A possible mechanism for internal loading of phosphorus in UKL is photosynthetically-elevated pH (Welch 1992; Sondergaard 1988; Jacoby et al.1982; Welch and Burke 2001; Walker 2001). Although this hypothesis is not universally accepted for UKL (e.g., Wood 2002), it has both theoretical and empirical support.

Role of pH in Upper Klamath Lake Water Quality

Hydrogen ion concentration (pH) is an important water quality parameter in UKL because it can affect aquatic organisms, including suckers, and is thought to be a key factor in internal loading of phosphorus. As discussed below under "Role of pH in Upper Klamath Lake Water Quality," pH values >9.55 cause a loss of equilibrium in juvenile SNSs; swimming performance of larval LRSs was reduced at a pH of 10.0, and pH values >10.3 are lethal to larval and juvenile SNSs and LRSs (Falter and Cech 1991; Saiki et al. 1999; Meyer et al. 2000).

During rapid growth, the biomass of *AFA* can reach "bloom" conditions, and if the bloom is large enough, and mixing/re-aeration are minimal, such as occurs when there is no or little wind, pH will increase because the rate of carbon dioxide fixation through photosynthesis exceeds the rate of input from the atmosphere, shifting the equilibrium between free carbon dioxide and carbonate ions in the water. This is especially a problem in UKL because of low buffering capabilities of its low-ionic strength waters. Thus, pH levels are related to the rate of photosynthesis and biomass of *AFA*.

Role of Dissolved Oxygen in Upper Klamath Lake Water Quality

DO levels are a primary factor affecting suckers and other aquatic species in UKL. ODEQ (2001) in the draft TMDL for the UKL sub-basin, has identified DO as exceeding state water quality criteria in 13% of samples on an annual basis and 35% for August samples; consequently UKL is listed as being water quality limited for DO. In any body of water, DO levels are influenced by a variety of mechanisms including photosynthesis, organismal respiration, sediment oxygen demand (SOD), carbonaceous biological oxygen demand and nitrification, and atmospheric re-aeration (Wood 2001). Of these variables, photosynthesis, SOD, and re-aeration have the most effect on DO concentrations.

SOD was studied in UKL by Wood (2001). SOD is critically important in a shallow and productive lake like UKL because, in the absence of DO production by photosynthesis and re-aeration by wind mixing, SOD has the potential to lower DO to levels that adversely affect fish. Wood (2001) estimated that potential water column DO concentrations resulting from SOD could be reduced to low levels in less than a day, if conditions are right.

As part of an oxygenation pilot project proposal prepared for Reclamation by Burleson Consultants (2002), a simple oxygen mass balance model was developed to assess likely DO demands in Shoalwater Bay, a potential site for supplemental oxygenation. DO demand was calculated as the sum of sediment and water column demands. Using their model and data, a simple simulation can be done to show the effect of reduced lake depth on DO levels (Table 4.1.1-2). In this simulation we start with a DO level of 6 mg/l and assume there is no surface re-aeration by wind mixing or any DO derived from photosynthesis.

Table 4.1.1-2. Simulation of water column DO concentrations at two water depths.

Depth (ft)	Sediment DO Demand (mg/l/d)	Water Column DO Demand (mg/l/d)	Total Daily DO Demand (mg/l/d)	Predicted DO after 1 Day if Start at 6 mg/l
7	0.8	0.9	1.8	4.8
3.5	1.6	0.9	2.5	3.5

In this example, DO levels after 1 day in the 7-ft deep water column are still relatively high, but in the 3.5-ft deep column they have dropped to levels that would be stressful, and if they continued to drop at this rate would reach levels known to be lethal to suckers in less than one additional day. Although this example is hypothetical it is not unrealistic for August conditions in UKL. This example also shows the critical role wind mixing has on DO levels because even low winds would have prevented the severe decline from occurring.

Winter Water Quality

During the winter months, *AFA* growth is minimal, most fish and other organisms are relatively inactive, and water quality conditions are generally good. However, ice-cover conditions can pose a risk to suckers because it eliminates wind-induced mixing which is responsible for oxygenation and release of potentially toxic un-ionized ammonia. Currently little is known about how winter water conditions affect suckers and aquatic other species. There are concerns about DO and un-ionized ammonia concentrations, especially under a prolonged ice-cover condition. This seems to be a condition that would most likely occur in shallow, isolated bays where ice-cover is likely to persist longest, where circulation is weakest, and where SOD could strip DO from the shallow water column most rapidly.

Potential Effects of UKL Water Depths on Water Quality

How UKL water depths affect water quality has been a subject of considerable debate. The focus of this debate should be water depth rather than lake elevation, since water depth is the factor that affects water quality. Changes in UKL water depth could potentially affect water quality through various mechanisms as discussed below. Currently, empirical support for these mechanisms is weak in most cases, but they are supported, in part, based on studies of UKL and other lakes, and from generally accepted limnological theory.

Disagreements among limnologists regarding the validity and importance of these mechanisms in influencing water quality in UKL is to be expected since UKL limnology is complex and available data were not specifically collected to answer the question about how changes in lake depth affect water quality. Thus, although UKL is relatively well studied, our knowledge of how it operates is still incomplete and our ability to answer questions such as how changes in lake depth might affect water quality is limited.

There are at least eight potential mechanisms that relate water quality to UKL water depth

(Welch and Burke 2001, Wood 2002, Welch et al. 2002). Each of these mechanisms is briefly discussed below and in more detail in Appendix E. These hypotheses can be divided into two groups whether the effects are direct or indirect to suckers: A) effects of water depths on parameters that directly affect suckers, such as those that affect DO and pH; and B) effects of water depth on parameters that indirectly affect suckers, such as those that affect nutrient availability and *AFA* productivity.

Hypothesis Group A: Those having direct effects on suckers.

A1. *Greater lake depth mitigates low DO values*.

DO levels in UKL are primarily dependent on four factors: (1) magnitude of senescing *AFA* and algae bloom (demanding more DO than is produced by photosynthesis); (2) ratio of bottom sediment (source of SOD) to lake volume, which can be approximated by the surface area to volume ratio (which increases from 0.1 at a lake elevation of 4143 ft to 0.25 at 4137 ft); (3) extent of wind-driven re-aeration; and (4) temperature, which determines rates of bio-chemical DO utilization and approximately doubles for each 10° C increase in temperature (Welch and Burke 2001).

Wood (2002) in a critique of lake level effects on water quality, states that this hypothesis is “conceptually straightforward and theoretically sound,” and its potential significance in UKL has probably been underestimated. The author continues by saying that the temporal component of this hypothesis could be particularly important because of the sharp decline in DO that occurs at night when photosynthesis ceases, and that the effect of lake level dilution on DO depletion would be most critical in the shallower areas (<1 m) of the lake where a minor change in depth can have a proportionally large effect on nocturnal DO depletion. Wood (2002) cites a study by Miranda et al. (2001) showing that in a shallow lake, the risk of reaching very low DO levels increased rapidly when depths were less than about 1 m, and the total area of shallow water changed with lake elevation.

Miranda et. al (2001) developed a simple model to manage risk of low DO to a fish population in a shallow, productive lake. The fish were experiencing annual die-offs associated with low DO. The researchers used a probability risk assessment to estimate the likelihood that the lake would be affected by critically low DO levels. The results indicated the importance of shallow depths (<1 m) in determining the area of critically low DO. It was also evident that water level management could be used to reduce the area of low DO concentrations, as well as reduce the extent of infrequent events that would otherwise affect large areas of the lake. The infrequent but large events were considered to be the greatest threat to the fish population because fish would be less likely to find refuge areas of higher DO.

The results of Miranda et. al (2001) are highly relevant to the situation in UKL because of similar conditions, i.e., recurrent fish kills caused by high primary production and low DO levels, and shallow water depths affected by lake level management. The hypothesis that infrequent, large-scale water quality declines affect the ability of fish to avoid lethal conditions also appears applicable to UKL. Low DO is very likely to be a continuing problem in UKL until *AFA* biomass is reduced, unless this condition is mitigated in some way.

A2. *Greater lake depth improves under-ice and winter water quality*.

Lake volume under ice-cover conditions could influence the rate of DO depletion in UKL. For example, a 3-ft change in UKL depth from 4140 to 4137 ft elevation results in a 30% reduction in mean water column depth. With a larger sediment to volume ratio at shallower lake depth, DO depletion will occur faster than at higher lake depths. Therefore, there could be a greater probability of low DO at lower depths. Welch and Burke (2001) estimated what DO levels in UKL could be under ice-cover condition and predicted that DO levels could reach values known to be adverse to suckers after <60 days of ice cover.

Un-ionized ammonia is also considered to be a potential risk to suckers during the winter and under an ice cover, as discussed above. The risk would be highest in shallow bays where the sediment area to volume ratio is highest. Greater lake depths could reduce this risk by dilution.

Although, there is good theoretical justification for a connection between changes in UKL water depth and the potential risk to suckers by under-ice conditions, there are no empirical data to corroborate this relationship and therefore further studies are needed. Furthermore, no evidence of a winter depletion in DO was found based on Reclamation’s data for a sampling site upstream from the Link River Dam.

A3. *Shallower lake depths improve DO levels*.

Vogel et al. (2001) and Horne (2001) proposed that “lower” UKL lake levels would bring water quality benefits, especially higher DO levels. The central point of the Vogel et al. hypothesis is that UKL suffers from low DO levels in summer because it is stratified. Most data indicate that UKL is usually well mixed, rather than becoming stratified in the summer, although it undergoes periods of fluctuating stability (Welch and Burke 2001; R2 Resource Consultants 2001). This distinction is not trivial since in truly stratified lakes, re-aeration of bottom waters by wind mixing is much reduced by water layers developed by distinct density differences. Welch and Burke (2001) conclude that a temporary lack of wind is the primary factor responsible for summer periods of increased water column stability (and the resultant lack of mixing and re-aeration) in UKL, which are responsible for periodic hypoxic conditions in the water column that lead to sucker stress and die-offs.

Wood (2002) points out that attempts to relate water column stability (as indicated by “RTRM”, relative thermal resistance to mixing) relationships to lake levels, must use water column depth as the independent variable, not lake levels, since depth varies over the lake at any one time. The author also suggests that the transient nature of water column stability cannot be fully appreciated when biweekly samples are the basis of the analysis, since they may change in 24 hrs owing to diel temperature fluctuations.

A4. *Greater lake depth reduces un-ionized ammonia concentrations*.

This hypothetical mechanism is similar to several others above in that it considers that an increase in lake depth (water volume) would dilute ammonia produced by microbial breakdown of *AFA* biomass. Some ammonia is taken up by phytoplankton including *AFA* as a nitrogen source. Un-ionized ammonia has been suggested as a factor in fish kills and in contributing to chronic stress both during the summer and the winter (Perkins et al. 2000b, Loftus 2001). This hypothesis is simple and plausible, and although not yet verified by empirical relationships from lake data, should nonetheless be operating in the lake. Wood (2002) states that "...if ammonia in excess of what the bloom incorporates continues to be liberated by temperature-dependent decay processes in the sediments that take-off in spring, it would make sense that more lake volume should provide some dilution."

Wood (2002) points out that ammonia levels in UKL have increased significantly since 1996 and perhaps this change was involved in the 1996 and 1997 fish kills. The explanation for the increase in ammonia during the last 5 years is being debated. Welch and Burke (2001) think it is related to low summer wind speeds that create water column conditions favoring ammonia production. Wood (2002) suggests there may be two processes related to ammonia production: one due to water column conditions whereby low DO shuts off nitrification allowing ammonia to increase; and one at the sediment-water interface where reducing conditions cause nitrogen to be converted to ammonia. However, Wood (2002) notes that there are features in the data set that don't fit either scenario.

Although this mechanism is likely operating in UKL**,** there are still many unanswered questions about what conditions lead to ammonia production, which appears to be associated with seasonally low DO conditions in the water column and sediment, and thus is related to *AFA* bloom declines. Consequently, efforts to reduce *AFA* biomass and ensure adequate DO levels are present in the lake will help offset the adverse effects of ammonia.

Hypothesis Group B: Those having indirect effects on suckers.

B1. *Greater lake depth reduces AFA biomass by reducing light intensities*.

Light intensity is attenuated rapidly when absorbed/scattered by phytoplankton as it passes through a water column (Reynolds 1986), and therefore lake depth could affect *AFA* growth. This effect is well documented for non-buoyant algae but is more complex since *AFA* can regulate their distribution in the water column to some degree. The significance of this effect depends on the degree that *AFA* remains mixed. Wood (2002) concluded that "...while it would be reasonable to assume some increase in light limitation, and consequent decrease in biomass and pH, occurs with increased elevation [depth] in UKL, this dependence on lake elevation [depth] is small compared to the larger inherent variability in these quantities due to climatic and other factors." Welch et al. (2002) argue that with the present data set its not possible to determine the relative size of the effect.

B2. *Greater lake depth retards AFA bloom initiation in the spring*.

Two factors that could delay the initiation of an *AFA* bloom in the spring through a deeper water column (greater volume) are: (1) reductions in light intensity at the bottom owing to increased depth (Welch and Burke 2001; Walker 2001); and (2) delay of increased water temperature since a larger water mass is slower to warm. Although factor #1 is reasonable, based on generally accepted limnological theory, it is currently not supported by empirical data from UKL. Wood (2002) suggests that factor #2 has a "sound theoretical basis," but is not likely to be significant since the average temperature of UKL tracks air temperature with only a short 1- to 3-day lag (Wood et al. 1996). Nevertheless, the author points out that perhaps a more significant factor might be the effect lake volume has on the magnitude of diel temperature fluctuations, since low temperatures at night might retard bloom initiation even if average temperatures were higher.

B3. *Greater lake depth reduces internal phosphorus loading*.

Several factors potentially relate changes in internal phosphorus loading to changes in UKL water depth. Empirical evidence from UKL along with supportive evidence from other lakes suggests that as an *AFA* bloom progresses and pH increases, this might increase the flux of phosphorus from the sediment to the water column. If water-column phosphorus increases it could result in a greater *AFA* biomass which leads to increased pH, setting up a positive feedback loop (Kann 1998; Welch and Burke 2001).

Wood et al. (1996) stated that a critical set of circumstances is required to initiate internal phosphorus loading; lake depth is only one of those circumstances, and its relative importance is unknown. Wood et al. (1996) concluded that the phosphorus data set they analyzed was insufficient to quantify the contributions of wind speed and duration, fetch, high pH, and lake level (four of the most easily identified relevant variables) to internal phosphorus loading. While the above relationship is largely un-documented for UKL, it is based on several mechanisms that appear plausible and are supported by some limnologists familiar with UKL. Further studies are needed to verify this relationship and to what degree it affects *AFA* biomass.

B4. *Greater lake depth reduces pH and AFA biomass*.

This hypothetical mechanism is related to the internal loading of phosphorus described in #3 above. Probability-based models of photosynthetically-elevated pH as a function of *AFA* biomass (as measured by Chl-a) were developed for both Agency Lake and UKL (Kann and Smith 1999). The models indicated that the highest pH would occur in Agency Lake which is about 30% shallower than UKL. Wood (2002) remarked that if lake elevation affected *AFA* blooms, then it follows that a lower pH would result, but the author also noted that a quantitative link between the two remains "elusive," and that "whether one accepts the theoretical arguments linking bloom size and lake level..., remains, unfortunately, a matter of belief and opinion, about which knowledgeable experts can legitimately disagree." .

Based on the above discussion, there are at least eight potential depth-related, mechanisms that could affect water quality. At least four of these could directly affect suckers survival. An additional four hypothetical mechanisms indirectly could affect suckers primarily through changes in *AFA* productivity. Although empirical relationships between lake depths and those water quality parameters affecting sucker survival has not been found in most cases, and there are reasons to question the significance of some proposed mechanisms. Nevertheless, most of the hypotheses are well supported by a variety of information including: 1) well established scientific principles such as conservation of mass (as it relates to dilution); 2) published and unpublished reports and data from UKL; 3) data published in peer-reviewed journals; and 4) professional opinion of limnologists who have worked extensively on the lake. The best support is for improved water quality resulting from deeper depths. Currently we are unable to document the magnitude of the effects, although models (described in Appendix E) predict in some cases how large an effect might be, additional data are needed to verify these predicted effects. Until new information is presented to the contrary, the Service concludes, based on an analysis of the best available scientific data, that there is credible reason to conclude that minimum UKL elevations could reduce the risk adverse water quality leading to fish kills.

Synopsis of Upper Klamath Lake Water Quality Conditions

- By the late 1800s, UKL was apparently nutrient enriched and experienced occasional fish kills.

- Although there are significant background levels of phosphorus, human-induced changes in the watershed as a result of forestry, agriculture and grazing, have greatly increased nutrient input to the lake.

- Wetlands, which comprised about 46% of the lake area, likely play an important role in phosphorus cycling and by producing humics that may have affected algae growth. Significant loss of wetlands (66%) through diking and draining is also a likely major contributing factor affecting nutrient enrichment and *AFA* productivity.

- By the mid-1900s, UKL had reached a hypereutrophic condition as a result of establishment of dense blooms of the cyanobacterium *AFA*.

- *AFA* blooms in UKL reach extreme levels of 200,000 cells/ml and Chl-a levels of >0.2 mg/l. As a result, acutely toxic, chronic, and stressful conditions for suckers and other fishes likely occur at some scale on an annual basis in the lake owing to high pH and un-ionized ammonia, and low DO concentrations.

- Shallow average depths in UKL and buoyancy of *AFA* could reduce effects of depth on light limitation, which occurs in UKL at depths as shallow as 3 ft.

- Internal loading of phosphorus contributes about 60% of the total lake phosphorous and is likely affected by a number of potential mechanisms, including shallow depths that promote wind-shear stress and resuspension of sediments, and a possible *AFA*-pH-phosphorous-*AFA* feedback loop that could increase internal loading of phosphorus and ensure that *AFA* growth is not nutrient limited.

- Low DO levels in UKL are primarily the result of high SOD, but water column respiration may be nearly as high. Based on measured SOD values, potential water column reductions in DO range from 0.4 to >3.7 mg/l/day in late summer, and in the absence of photosynthesis and wind-driven re-aeration, DO could be reduced to lethal levels in as little as one day.

- The severity of low DO levels in the early morning is likely to increase at shallow depths because of the greater sediment area to water-volume ratio.

- The dominant factors controlling water quality in UKL are weather and climate.

- Greater lake depths may improve water quality through a variety of hypothetical mechanisms by: (1) reducing wind re-suspension of bottom sediments thus reducing internal nutrient loading, and thus reducing *AFA* productivity; (2) reducing mean water-column light intensities thus reducing *AFA* productivity; (3) diluting pH, thus reducing the effect of the theoretical *AFA*-pH-phosphorous feedback loop; (4) diluting phosphorus and ammonia, and other nutrients, thus reducing *AFA* productivity; (5) increasing the lake volume to sediment area, thus decreasing the effect of sediment DO demand on water-column DO, both during the summer when metabolic processes are high, and in winter, under ice-cover conditions when aeration ceases.

- Shallower lake depths likely do not improve DO levels in UKL because water column stability is primarily a function of wind speed rather than lake level and as depth declines the sediment area to volume ratio increases thus increasing the rate of DO depletion by SOD.

- Although simple empirical relationships between lake depths and water quality are largely lacking for UKL, there is a substantial body of theoretical information and study results from UKL and other lakes indicating that greater lake depths would most likely improve water quality, at least incrementally.

- Finding a simple empirical relationship between UKL depth and water quality is problematic owing to: (1) previous sampling is likely not adequate to answer this question; and (2) UKL limnology is highly complicated by its large size; shallow but diverse bathymetry and shoreline morphology; high susceptibility to air/water/sediment interactions; patchiness of biological and other processes; and other factors.

Environmental Conditions and Their Causal Relationships to UKL Fish Die-offs

Laboratory and *in situ* studies indicate that water quality in UKL reaches levels known to be stressful or lethal to suckers and other fish (Martin and Saiki 1999, Saiki et al. 1999**,** Meyer et al. 2000, Perkins et al. 2000b). This finding is supported by other observations showing that fish kills may not be unusual in UKL. When ichthyologist, C.H. Gilbert visited the lake in June 1894, a fish kill was apparently underway because many dead and dying fish were observed

(Gilbert 1898). Fish kills were also reported in 1932, 1971, and 1986 (Buettner 1997). In 1971, a series of articles appeared in the *Herald and News* regarding a large fish kill in UKL that affected an estimated 30 million fish, mostly chubs (Briggs 1971). It is very likely that other fish kills occurred in the lake in the 19th and 20th centuries but were not reported.

Data indicate that the 1996 die-off was linked to a combination of meteorological and biological conditions (Perkins et al. 2000b). Specifically, warm weather and relatively calm wind conditions during July and August led to warm water temperatures, stratification of the water column, and increased biological activity. Warm temperatures increased respiration rates and sediment and water column DO demand, as well as lowering the capacity of the water to hold DO. A lack of wind-mixing likely reduced surface aeration and consequently fish were exposed to stressful levels of low DO leading to disease outbreaks and mortality. Sucker susceptibility to low DO could have been enhanced by prior or simultaneous stress due to exposure to high pH and high un-ionized ammonia concentrations, and low DO levels during the prior summer months.

In reviewing Klamath Falls meteorological data records, weather conditions before and during the 1996 die-off were unusual. For example, the mean monthly July temperature was 73.5° F, making it the second warmest in 69 years of record at the Klamath Falls airport. The August mean monthly temperature, 70° F, was ranked 11th over the 69-year record. Warm weather was also associated with previous fish die-offs in 1995, 1986, and 1971. Klamath Falls wind data also indicate that July 1996 was ranked 4th out of the last 27 years for lowest mean monthly wind speed.

Another factor in the 1996 die-off was the bacterial disease "Columnaris,"caused by *Flavobacterium columnare*. Columnaris disease is likely to be more of an indicator of severe stress rather than the cause of mortality during a fish kill. Elevated water temperatures and other stressors likely predisposed fish to infection (Holt 1996, Foott 1996). Holt (2001) did some follow-up work on Columnaris obtained from suckers killed in the 1996 fish kill and found that isolated strains were of low virulence, suggesting that Columnaris may have had only a minor role in the 1996 fish kill and that water quality was the primary causal factor.

Although sucker die-offs have received the most attention, adverse water quality will stress fish prior to causing mortality. Loftus (2001) evaluated the Klamath Tribes and USBR long-term water quality data set for UKL to assess when water quality would likely cause stress. Such stress, although not acutely lethal could have significant adverse short-term and long-term effects (e.g., reduced growth and reproduction; and increased susceptibility to disease, parasitism, physical abnormalities, and predation) and could be a factor leading to mortality and reducing overall fitness.

Documented fish kills are not directly related to lake depths in any simple way, if they are related. Fish kills occurred in years of average, above-average, and below average, median August lake level elevations (Welch and Burke 2001). Median August lake elevations are the most appropriate data for comparing lake levels and fish kills because August was the month when most kills occurred. Lake elevations in 1971 and 1995 were above average; 1986 was average; and 1997 and 1996 were below average. In 1992 and 1994, when two of the lowest elevations occurred, significant fish kills were not detected, but DO levels were low (Welch and Burke 2001), and had weather conditions been different, such as low winds speeds and higher temperatures, there is a high likelihood that there would have been significant die-offs. Data show that 1992 and 1994 were windy (Welch and Burke 2001) and under these conditions ammonia and DO levels are moderated by mixing (Welch and Burke 2001).

The hypothesis put forth by Wood (2002) that a large pulse of nutrients flowing into UKL as a result of flood flows in the spring can trigger later *AFA* blooms should be considered when discussing the cause of massive fish kills. This could explain why lake levels and fish kills are not related since Wood’s hypothesis is based on inflow events not lake levels.

The NRC (2002) recently stated in their interim report that no “clear connection” exists between UKL elevations and fish die-off events. Although existing analyses have not found an empirical relationship between lake levels and fish die-offs, a relationship may exist. There appears to be three potential ways in which lake levels and fish die-offs might be related: (1) higher levels might promote die-offs; (2) lower lake levels might promote die-offs; and (3) lake levels and die-offs are unrelated. Previously in this section we presented an analysis of the potential relationships between changes in lake depths and water quality. Our conclusion is that, although, an empirical relationship between water levels and water quality is lacking, there is a substantial amount of scientific information to suggest that such a relationship exists, and that risk to suckers is likely reduced at higher lake levels. There are logical reasons why it would be difficult to find a relationship between lake levels and fish die-offs or between lake levels and the major processes that affect fish kills.

The Service believes, based on the best available science, that lake levels per se do not cause fish kills; they likely can, however, contribute to or mitigate conditions that cause fish kills and also likely affect the number of fish that die. Evidence that such relationships exist are most likely to come from directed studies that are specifically designed to answer this question.

4.1.2 Gerber Reservoir

Gerber Reservoir is relatively deep, with a mean depth of >20 ft and a maximum depth of >60 ft, allowing the reservoir to stratify and undergo oxygen depletion below the thermocline. The reservoir is often drawn down very low. For example, in October 1992, following a 6-year drought, Gerber Reservoir reached a minimum elevation of 4796.4 ft, which is <1% of its maximum capacity. Aeration was used to maintain water quality during the preceding summer as reservoir levels dropped. Reclamation biologists found that SNSs in the reservoir at that time showed signs of stress including low body weight, poor gonadal development, and reduced juvenile growth rates (Buettner, USBR, pers. comm.).

In 1992, an extremely low lake level year, low DO conditions were documented during the summer months by Reclamation; most values ranged from 4-6 mg/l throughout the water column. In June 1992, DO reached a low of 1.1 mg/l at the bottom of the reservoir near the dam, and DO readings < 4 mg/l were recorded from May through mid September (USBR, unpubl. data).

In 1993, a wet year with relatively high lake levels, water quality conditions were much better than 1992 (USBR unpubl. data). DO concentrations were low during January and February in association with ice-cover conditions. DO readings ranged from 3-6 mg/l in the top several meters and as low as 1.5 mg/l near the bottom. In June, DO readings were 7-8 mg/l, dropping to less than 2 mg/l in August-October. This change was associated with stratification of the lake. A DO level of approximately 2 mg/l is considered a high potential risk for suckers.

Water quality conditions in 1994, which was a low reservoir level year when the reservoir reached only 12% of capacity, were similar to 1993. In January and February, during ice-cover conditions, DO concentrations were relatively high in the upper 5-8 m (6-11 mg/l) and decreased to less than 1 mg/l at the bottom. *AFA* blooms occurred in July and August influencing pH and DO conditions. DO levels remained above 4 mg/l in the top 3-5 m. Lower DO concentrations were recorded at deeper depths during July and August.

Following the droughts of 1992 and 1994, inflows to Gerber Reservoir were relatively high owing to above average precipitation. As a result, physical and chemical habitat conditions in Gerber Reservoir apparently remained good with no adverse effects to suckers noted.

4.1.3 <u>Lost River</u>

High temperatures, low DO, elevated nutrients, and high levels of suspended sediments are considered to be problems in the Lost River. The Lost River is on the State of Oregon's Clean Water Act section 303(d) list for several water quality parameters that fail to meet minimum state limits including: DO, pH, temperature, bacteria, and Chl-a. Koch and Contreras (1973) noted that water temperatures in April were highest in the upper Lost River below Clear Lake Dam and Chl-a levels were highest in the Langell Valley where flows were low owing to a lack of dam releases.

Shively et al. (2000b) found that DO levels in the Lost River were below State of Oregon standards of 5.5 mg/l at all stations except North Canal, which gets its water from Miller Creek. DO levels were lowest in Wilson Reservoir, where they were near 1 mg/l, but were also low at other stations downstream from Wilson, including #5 Drain, Anderson Rose, and East/West Bridge. It can be concluded that water quality in the Lost River limits habitat for all fish, including the LRS and SNS, and can be seasonally lethal.

4.1.4 <u>Tule Lake Sumps</u>

Tule Lake is classified as highly eutrophic because of high concentrations of nutrients and resultant elevated aquatic plant productivity (Winchester et al. 1994; Dileanis et al. 1996). Because Tule Lake is shallow and the nutrient content is high, aquatic plant and phytoplankton activity cause large fluxes in levels of DO and pH.

During the irrigation season, water reaching the sumps has been used an average of three times by being applied to agricultural lands (Orlob and Woods 1964). Tule Lake water quality is affected by its various sources of inflow. During the irrigation season, the primary source is UKL, via the Lost River Diversion Canal and A-canal. UKL is highly eutrophic as discussed previously, with large, near-monoculture blooms of *AFA* occurring almost continuously from spring through fall (Kann 1998). Associated with the blooms are extreme water quality conditions such as high pH and low DO levels (Dileanis, 1996). Water from Clear Lake and Gerber reservoirs also flows into Tule Lake sump 1A through the Lost River after receiving agricultural return water from the Langell Valley, Horsefly, Poe Valley, Klamath and Tule Lake Irrigation Districts. Agricultural return flows contain higher concentrations of dissolved salts including sulfates and nitrates, as well as ammonia and pesticides, than the source waters.

Water quality can vary greatly both seasonally and diurnally, especially in the summer. Due to the lake's shallowness and high biomass of aquatic macrophytes and filamentous green algae during the summer, DO and pH levels fluctuate widely. During the winter, most inflow to Tule Lake is from localized runoff. Water quality conditions during this time of year are relatively good, except during prolonged periods of ice-cover when DO levels decline. Reclamation has documented surface temperatures at Tule Lake up to 26° C, and DO levels from super-saturation, >15.0 mg/l, to near zero; pH occasionally exceeded 10.0 (USBR, unpubl. data).

Bioassays have shown that agricultural drain water and water within the Tule Lake sumps are seasonally toxic, owing to low DO and high pH and ammonia levels, to some test aquatic organisms including *Daphnia* sp. and the fathead minnow (Littleton 1993; Dileanis et al. 1996). In 1991 and 1992, Dileanis et al. (1996) found that un-ionized ammonia concentrations were at potentially toxic levels in water sources, drains and receiving waters around the Tule Lake sumps, but the sumps produced the highest percentage of values above the Environmental Protection Agency toxic criterion of 0.02 mg/l, depending on pH and temperature. Although un-ionized ammonia is of concern, over the short term, the frequent low DO levels in the Tule Lake sumps may pose the greatest threat to aquatic life, including fish (Snyder-Conn, USFWS, pers. comm.).

If suckers are somehow able to survive water quality conditions in the sump, it is likely that decreases in water depth in the Tule Lake sumps may ultimately make the sumps too shallow for suckers. Between 1958 and 1986, approximately 30%, or 14 inches, of depth was lost in the sumps owing to sedimentation. The shallow depths also exacerbate low DO conditions as a result of the high sediment area to volume ratio.

A variety of pesticides have been detected in waters and sediments around Tule Lake; however, the levels are below those known to be acutely toxic to aquatic life (Dileanis et al. 1996).

4.2 Ongoing Watershed and Stream Alterations

Watershed and stream alterations can affect sucker habitat and water quantity and quality. Hydrologic alterations can directly affect spawning habitat. The preferred sucker spawning substrate is gravel, and since eggs are broadcast, they will settle among the stones. Hydrologic changes that alter normal bedload movement and scour and fill patterns can excavate or bury eggs, exposing them to stream flow, and trapping or crushing eggs or fry. Increasing levels of fine sediments affects developing embryos by filling interstitial spaces within stream substrate, reducing or eliminating water flow through the substrate, cutting off the supply of oxygen, causing waste products to build up, and may be sufficient to reduce or eliminate the ability of larvae to emerge from the substrate. Hydrologic and sediment regimes can be altered by vegetation removal, site disturbance, and soil compaction associated with activities such as timber harvest, grazing, channelization, road construction, and clearing of riparian vegetation.

Degraded stream channels are often a result of higher peak flows and increased sediment loads resulting from watershed alterations. Streams may become incised, no longer allow over-bank flooding, and thus all energy must be dissipated with the channel resulting in increased channel erosion. Also, less water is stored in the flood plain resulting in decreased base flows in late summer and fall.

One of the most damaging watershed alterations is compaction of soils, causing faster runoff of surface water such as along road ditches. Roads, because they consist of compacted and impervious soils, act as extensions of the drainage system by redirecting subsurface water to the surface and routing it into stream channels more quickly. This results in increased storm flows, as discussed below, and reduced base flows in streams. Base flows may also be reduced when fire suppression leads to higher densities of trees. Reduction of base flows contributes to reduced water quality in sucker habitat. Risley and Laenen (1999) noted changes in flows in the Williamson and Sprague rivers when pre-1950 flow data were compared to more recent data. These data were insufficient to allow determination of what land use was responsible for the change, but agriculture, forestry, and grazing are the major land-disturbing actions in the watershed.

Although water temperatures in the Klamath Basin rarely, if ever, get sufficiently high to be lethal to suckers, they do affect suckers in a variety of ways, such as *AFA* blooms and associated changes in water quality, as discussed above. Locally, suckers may seek out areas of better water quality, where lower temperatures and higher DO concentrations occur during summer (Bond et al. 1968; Hazel 1969; Bienz and Ziller 1987; Buettner and Scoppettone 1990). High temperatures may be involved with heavy parasite loads on suckers and other fish that occur in Clear Lake (Snyder-Conn, pers. comm., 1999).

Although high temperatures can contribute to seasonally stressful water quality conditions, they may also contribute to high sucker growth rates. Terwilliger et al. (2000) found that within the 15 to 24° C range of summer temperatures that juvenile suckers in UKL experienced in 1997, growth was fastest at the highest temperatures. This suggests that higher temperatures, and associated increased growth and available food, may benefit suckers as long as water quality conditions do not become overly stressful or lethal.

The ODEQ (1988) has identified nearly 25 stream segments flowing into UKL as being temperature limited. Groundwater entering streams, especially small streams, may be an important determinant of stream temperatures (Spence et al. 1996), or may provide localized thermal refuges. Where groundwater flows originate above the neutral zone, approximately 50-60 ft below the surface, groundwater temperatures will vary seasonally, as influenced by air temperature patterns (Spence et al. 1996). Groundwater recharge is reduced when soil interstitial spaces are lost or soil “pipes” fill owing to soil compaction.

4.2.1 Forest Practices

Forests in the Klamath basin have been managed for timber production, with substantial activity in the 1925-1940 period, peaking at 800 million board feet per year. The current harvest rate is much less. Extensive timber harvesting, including partial cutting with overstory removal, clearcutting, and selective logging for old-growth pine occurred on private lands, and low intensity harvest occurs on some U.S. Forest Service lands.

The Service assumes that forestry practices using accepted best management practices (BMPs) have minimal impacts to listed species, including suckers. However, it remains to be determined whether acceptable BMPs are being fully implemented in areas where they could affect suckers. Timber management affects listed suckers through a variety of impacts or alterations to watershed structural conditions and functional capacity. The primary pathways for negative impacts are through alterations of stream temperature patterns, hydrologic and sediment regimes, and reduction of channel complexity as well as the structural features that maintain channel complexity. Potential adverse effects also include introduction of pollutants (e.g., fuels, fertilizers, pesticides, and herbicides) into watercourses while conducting harvest, site preparation, stand maintenance activities, and wildfire suppression.

4.2.2 Agricultural Practices

Agriculture consumes >90% of water used in the Upper Klamath Basin. Agriculture, directly or indirectly, has been the most significant factor affecting aquatic species in the basin. Agriculture, including livestock grazing, is the major anthropogenic factor affecting UKL water quality (Gearheart et al. 1995). Likewise, the contribution of sediment into UKL and its tributaries owing to agriculture (and forestry) is likely to be very high as well as is indicated by sediment analyses in UKL (Eilers et al 2001). The combined effect of wetland conversion and agricultural use of former wetlands has had a major adverse effect on water quality in the lake (Snyder and Morace 1997) and has reduced habitat quantity and quality, reduced lake volume, and reduced buffering capacity of wetlands. Loss of riparian vegetation on tributary streams, as a result of farming practices and grazing, has likely led to increased stream temperatures, reduced base flow, and modification of stream channels. Flow diversions reduce base flows decreasing fish habitat and resulting in increased stream temperatures. Unscreened diversions also entrain fish, including suckers. Every major tributary flowing into UKL has been modified directly or indirectly by agriculture and grazing.

As discussed previously in this document, irrigation diversions affect listed suckers by altering stream flow and through entrainment. Listed suckers may enter unscreened irrigation diversions and become stranded in ditches and on agricultural fields. Basin streams are also channelized in some agricultural areas, especially in the Lost River drainage, reducing stream length and area of aquatic habitat, altering stream channel morphology, and diminishing aquatic habitat complexity. Additionally**,** instream flows are reduced in the Lost River after irrigation ends each fall because flows from Clear lake and Gerber Dams are terminated.

Intensive livestock grazing historically occurred throughout most of the Klamath River basin, and continues to be widespread (Light et al. 1996). Livestock grazing is a major land use within the Sprague River drainage, mostly in the lowland meadows and to a lesser extent in some forested areas. Confined animal feeding operations, such as dairies, where relatively large numbers of cattle are confined in a small area can lead to severe water quality effects when runoff goes directly into a waterway. Increased biological oxygen demand, *E. coli*, and nutrients are the primary factors involved. Such operations do occur in the Lost River watershed and have been identified as contributing to water quality problems. Several dairies in the Lost River area have been recently fined by EPA for water quality violations.

The Oregon Department of Agriculture (ODA), through Oregon State Senate Bill 1010, is working with the agricultural community to help them meet TMDL requirements set by ODEQ. All of the sub-basins in the upper Klamath Basin of Oregon are developing TMDLs which will need to be approved by the EPA. The Service is fully supportive of these efforts since they have a potential to significantly improve water quality and will therefore reduce threats and aid in the recovery of listed suckers.

The Service also believes that adoption of grazing BMPs such as riparian fencing, off-site watering, pasture rotation and resting, as well as attention to areas where cattle use is concentrated in winter, can do much to improve watershed and stream function, and water quality in the Basin.

4.2.3 Irrigation Diversion Dams

Dams have played a major part in the decline of the LRS and the SNS. Dams block migration corridors, isolate population segments, may result in stream channel changes, and alter water quality and provide habitat for exotic fishes that prey on suckers or compete for food and habitat with them. Most of the dams affecting the LRS and SNS are part of the Klamath Project or are owned by PacifiCorp, and are part of the proposed action, and therefore are discussed under the "Effects of the Action" section of this document. Chiloquin Dam is the only major dam affecting suckers that is not part of the proposed action.

Suckers are known to have migrated some distance up the Sprague River to spawn (Andreasen 1975). Chiloquin Dam on the Sprague River is thought to restrict upstream spawning migrations of the LRS and the SNS. The Chiloquin Dam was constructed in 1928 near Chiloquin. Andreason (1975) reported that passage was poor for all species in the late 1940s. A new fish ladder was built in 1965 but in the 1970s it was not passable for fish at all river stages. Consequently most LRS and SNS spawning is concentrated into a short reach on the lower Sprague River, making it easier for predators to locate the eggs and for spawning activity to expose eggs from previous spawners. Additional discussion of the effects of irrigation diversion dams will be presented in the "Effects of the Action" section of this document.

4.2.4 Urban Area Activities

Human population densities in most of the UKL watershed are relatively low. Small towns like Chiloquin, Bly, and Merrill are unable to afford state-of-the-art wastewater treatment facilities, and thus they may contribute to water quality problems. Leaking septic systems located near water bodies have been identified as a problem (Klamath County 1995). Klamath County has prepared an assessment of water resources that provides many recommendations for water quality improvements. The Service is unaware of the current status of implementation of these recommendations. The County does have minimum set-back regulations for placement of septic systems and for development. These restrictions should help reduce adverse impacts to aquatic ecosystems.

Residential development in the Klamath Falls area and Merrill have likely had some negative effects on the LRS and the SNS through reductions in water quality. However, since the largest concentrations of listed suckers is upstream from urban areas, impacts are limited to Lake Ewauna and adjacent upper reaches of the Klamath River, and the Lost River below Merrill. Improvements to the city of Klamath Fall's wastewater treatment facility are expected to help improve water quality in Lake Ewauna. However, the lake is also adversely affected by nearly a half-century of log storage. Bark deposited on the bottom of the lake has a significant biological oxygen demand as it decomposes. Logs are still being stored in rafts downstream from Lake Ewauna and are believed to be contributing to poor water quality in that area (E. Snyder-Conn, pers. comm.).

4.2.5 Ongoing Effects of Exotic Fishes on Suckers

In the final rule to list the suckers, the Service identified exotic fishes as a threat through predation and competition (Service 1988). The Upper Klamath Basin presently contains 17 taxa of native fishes (Logan and Markle 1993b; Moyle 1976; Shively et al. 2000; S. Reid, Service, pers. comm., 2002). Of these, at least 13 are endemic taxa and found only in the Basin. At least 18 species of exotic fishes have been introduced and have established populations in the upper Basin. Little is known about the ecological and competitive interactions of the introduced fishes with the native suckers and this a major gap in our ability to assess their impact. Many of the introduced fishes are predators which could prey on larval and juvenile suckers. Some exotic fishes have become sufficiently numerous and, because of their feeding habits, could be potential threats to suckers (e.g., the fathead minnow and the yellow perch, *Perca flavescens*).

Fathead minnows were first reported from Spencer Creek in 1974 and in UKL in 1979. By the mid-1980s the population had exploded (Bienz and Ziller 1987) and has since increased in abundance to where it is now frequently the most abundant fish captured in both UKL and the Lost River (Simon and Markle 1997b, 2001; Shively et al. 2000b). Fathead minnows generally occupy the same near-shore habitat as larval and juvenile suckers and may be significant predators on larvae. Concern about the potential impacts of the fathead minnow on sucker larvae prompted The Klamath Tribes to assess their predatory capabilities (Dunsmoor 1993; Klamath Tribes 1995). Dunsmoor (1993, Klamath Tribes 1995) examined predation of larval suckers by fathead minnows in the lab. He found that larvae were most susceptible to predation when water depth was shallow, there was an absence of cover, and the larvae were young. Increased water depth, increased cover, and increased age all reduced predation rates. Adequate vegetative cover was an important variable in these experiments and suggests that emergent vegetation may play a critical role in reducing larval sucker predation.

Currently, the effect of exotic fishes on listed suckers is not well understood. They are most likely a concern in areas where the habitat is highly altered and suckers are not doing well for a number of reasons. For example, in UKL, exotic fishes may play a synergistic role with other factors (e.g., effects of entrainment and adverse water quality in larval mortality) especially when lake levels are too low for larvae to find cover in emergent vegetation. However, many native fishes such as sculpins and chubs, are also likely important predators on larval fish. The critical factor is to restore ecological balance to the system and recover sucker populations to levels that can persist under the effects of predation and other threats.

4.3 Summary

LRS and SNS populations have been and continue to be adversely affected by many factors, as described above and in more detail in Appendix E. Historically, the major adverse impact was direct habitat loss as aquatic habitat was reclaimed for agriculture. This resulted in the near complete or total loss of the Tule Lake and Lower Klamath Lake sucker populations, which were perhaps as large or even larger than those in UKL. Construction of the railroad dike in 1912 and additional land reclamation resulted in eventual loss of suckers in Lower Klamath Lake and perhaps eliminated significant areas of rearing habitat for juvenile suckers originating in the UKL sub-basin. These losses were somewhat mitigated for by construction of Gerber and Clear Lake dams, increasing sucker habitat in the upper Lost River sub-basin. Fish eradication measures in Lake of the Woods eliminated the distinct and isolated sucker population there.

Sucker populations in UKL sub-basin have been affected differently than those in the Lost River and Lower Klamath sub-basins. UKL populations were not affected by single large actions but rather by a series of smaller, incremental actions that continue to have adverse effects today. Unlike the Lost River and Lower Klamath sub-basins, where there were large-scale habitat losses, habitat loss in UKL sub-basin has been primarily through degradation and loss of wetlands and riparian habitats, as well as water diversions and entrainment and blockage of passage. This is not to say that the other sub-basins are not experiencing habitat degradation, but rather habitat loss was so complete in the Lost River and Lower Klamath Lake systems that little original habitat remains. An example is the Tule Lake sumps, which provide habitat for a few hundred suckers and is filling in with sediment to the point where relatively little of the available habitat is used and access to spawning sites is blocked. The origin of existing suckers in Tule Lake may even be from those that were entrained into A-canal and thus might be from UKL.

Early in the 20th Century, UKL sucker populations suffered progressive degradation of spawning habitat owing to water development, land reclamation, and poor land management. Historical sucker spawning areas in UKL tributaries (including Crooked, Crystal, Sevenmile, and Odessa creeks, and Fourmile Creek and Slough; and Barkley, Odessa and Harriman Springs, and at least four other springs in UKL) have disappeared or significantly declined in the past 50-75 years. Construction of Chiloquin Dam likely reduced upstream spawning migrations, and degradation of upstream habitat likely further reduced upstream spawning. Sport fishing likely had a major effect on UKL suckers by harvesting adult suckers and reducing their reproductive potential until it was closed just prior to the listing of the suckers under the ESA in 1988.

Currently, the major factors adversely affecting suckers in UKL are water quality, habitat loss and degradation, and entrainment. Water quality degradation in the UKL watershed, as discussed above, was likely progressive. Although water quality in UKL was seasonally poor near the end of the 19th century, as evidenced by early reports, *AFA* was likely not a significant factor until about the middle part of the 20th century, as indicated by micropaleontology studies. It is likely that *AFA* became more significant as nutrients, especially phosphorus, from anthropogenic sources supplemented already abundant nutrients from natural sources. As a result, UKL went from a eutrophic state of high productivity to a hypereutrophic state, where primary production reaches a maximum where it is only limited by the availability of light.

As a result of a higher trophic state, water quality in UKL experiences severe declines on an annual basis. Dissolved oxygen, pH, and un-ionized ammonia all reach levels known to be stressful to suckers, and at times are lethal, and have been tied to recurring fish kills. UKL has undergone three significant fish kills in the past decade, owing to *AFA* bloom/decay cycles. Fish diseases, such as Columnaris disease, may be increasing in frequency as suckers become stressed by poor water quality conditions. High rates of parasitism and abnormalities in suckers have been noted as well, and may be an indirect result of water quality degradation and stress.

4.4 Habitat and Water Quality Improvements as a Result of Restoration Activities

Restoration of aquatic habitats to improve sucker habitat and water quality, and restoration in uplands to improve watershed function has occurred in the Upper Klamath Basin and is likely providing benefits to suckers. For example, Walker (2001) stated that some improvement in water quality has already been detected since TP levels in UKL have been reduced by about 10% in the past decade. If anthropogenic phosphorus can be cut another 20 to 40%, it is anticipated that water quality in UKL will significantly improve; perhaps to the point where fish kills will be less frequent and smaller in magnitude.

Since the Klamath Basin Ecosystem Restoration Office (KBERO) was established in 1993, five habitat restoration programs have been implemented. Restoration projects include, but are not limited to, wetland restoration, riparian vegetation re-establishment, management of livestock grazing, road rehabilitation, stream bank erosion control, flood plain restoration, and related assessments, research and outreach activities. Activities in the last five years have emphasized actions in the UKL systems above Link River Dam and secondarily, the Lost River systems. A summary of program activities is presented in Table 4.4-1.

Table 4.4-1. Restoration dollars spent in the Klamath River Watershed through KBERO, from 1994 - 2001.

Restoration Program / Fiscal Year	Bureau of Reclamation $ (x1000)	Hatfield Restoration Program $ (x1000)	Jobs-In-The Woods $ (x1000)	Partners for Fish & Wildlife $ (x1000)	Total Funding $ (x1000)
1994-2001	4,747	5,852	1,108	916	12,623

It is recognized that this accounts only a portion of the many state agency and other Federal programs, as well as private landowner initiated projects, that are having positive benefits to water quality and endangered sucker habitat in the upper Klamath Basin.

KBERO recently reported on projects that were at least partially funded by KBERO programs (KBERO 2002). Highlights of that report are covered below. The focus of the analysis was on projects that are benefit suckers and water quality affecting UKL and its tributaries. In the KBERO analysis, five basic categories were developed to describe restoration accomplishments (Table 4.4-2). Acreages and stream miles are reported as “protected”only if they meet the criteria be being functional in providing known benefits to endangered sucker recovery, that is: water quality, spawning, migration, adult, juvenile, and larval habitat (USFWS 1993). Projects were identified as providing these benefits by using professional judgment through direct monitoring and other reports and inquiries.

Not all projects were reported in the KBERO because insufficient time has elapsed to achieve environmental benefits. Projects that relied heavily on passive restoration may take 10-15 years following implementation to become fully functional. Projects occurring in closed basins and projects on intermittent streams are not included, nor were projects on USFWS refuge lands. KBERO estimated that 60% of active and planned restoration actions are not yet functioning and are therefore not reported. All of these plus many new projects are expected to provide additional benefits over the next 10 years. Outreach and education, research, and assessment projects have benefits that do not lend to direct reporting of changes in the environment. However, their importance in initiating positive environmental change cannot be overemphasized.

Table 4.4-2. Number of stream miles and wetland acres providing benefits to endangered LRS and SNS with KBERO involvement.

		Watershed				
Analysis Category	**Constituent element(s) likely benefitted**	**Upper Klamath Lake (Miles/ Acres)**	**[1]Williamson River (Miles/ Acres)**	**Sprague River (Miles/ Acres)**	**Lost River (Miles/ Acres)**	**Totals**
# perennial stream miles protected by fence or other management practice	Water Quality	12.35mi	15.5mi	24.2mi	23.75mi	**75.8mi**
# miles of protected riparian stream habitat occupied by endangered suckers	Larval and Juvenile migration and rearing habitat	5.35mi	6.6mi	5.95mi	1.25mi	**19.15mi**
# acres of seasonal or permanent wetlands restored and/or protected	Water Quality	6395ac	160ac	5143ac	880ac	**12578ac**
# acres of UKL former wetlands that are now permanently flooded	Water Quality in Upper Klamath Lake	5100ac	----	----	----	**5100ac**
# acres of UKL drained wetlands that are now hydrologically connected to UKL	Water Quality/ Larval and Juvenile rearing habitat	950ac	----	----	----	**950ac**

[1] TNC Williamson River Delta wetlands and BLM Wood River Wetlands are reported in UKL watershed

The Wood River Wetland Project initiated by BLM in 1994 was the first major restoration project in the upper Basin. It re-flooded 3,000 acres of drained wetlands near Agency Lake. Management of these drained wetlands have reduced total phosphorus loading from the property to UKL by 91% (1.3 metric tons) (Turaski and Watkins, 2001). This is 3% of total phosphorus of the average nutrient load in the Wood River measured by Kann and Walker (2001). Summer warming rates have decreased approximately 1.0 ° F per mile over the 3-mile project reach, when climatic variables were factored out (BLM, unpub. data, 2001). Reduction in warming rates was attributed to reduced stream width.

Less quantifiable benefits from the Wood River project include increased quantity and quality of shoreline and flood plain habitat along the lower Wood River. The Wood River project created shoreline vegetation that remains flooded and accessible to larvae when at lower lake and river levels. Wetland and riverine function has been improved by the restoration of 25 acres of a well vegetated flood plain on the west side of the river and an increase in differential head between the river and surrounding marsh. Increased over-bank flow on approximately 700 acres of existing deltaic wetlands has increased nutrient and particulate filtering capacity and access for feeding larval and juvenile fish.

Other promising UKL wetland projects include The Lower Williamson River Delta Project implemented by The Nature Conservancy (6400 acres), Reclamation's Agency Lake Ranch water storage project (7,200) acres, Running Y Wetlands (550 acres) and Lakeside Farms (50 acres). These projects, totaling nearly 15,000 acres, are in various stages of implementation and area expected to yield similar habitat and water quality benefits as the BLM Wood River Wetland project. Table 4.4-3 compares restored wetland acreage to historic in UKL and predicted acreages assuming current funding levels over the next 10 years. Given recent congressional initiatives, it is likely that funding levels for restoration will increase substantially over the next ten years.

Table 4.4-3. Comparison of protected wetlands and streams to potential conditions in the UKL Watershed. Ten year predictions of restoration actions were calculated by simply applying a 2.7 multiplier (16 years divided by 6 years since program inception) to calculated values.

Watershed	***Upper Klamath Lake***			
	Protected miles/acres	[2] Potential miles/acres	% below potential or converted[2]	Predicted restored in yr 2011
2. # Stream Miles protected	12.35mi	240mi	50-70%	33mi
3. # miles sucker habitat protected	5.35mi	100mi		14.3mi
4. # acres other wetlands protected	6,395ac	40,000ac	unk	17,100ac
5. # acres former UK marsh flooded	5,100ac	51,500ac	66%	13,600ac
6. # acres UK marsh sucker habitat	950ac	51,500ac	66%	2,530ac

[2] Acreage of drained Upper Klamath Lake Wetlands from Geiger, 2001; Number of miles of stream below potential estimated from channel assessments in ODEQ (2001).

External phosphorus loading from the Sprague and Williamson River accounts for about 46% of the total external load (Kann and Walker 2001). Analysis of existing stream and riparian conditions in the Upper Sprague and Williamson Rivers by ODEQ shows that a high percentage of the main-stem rivers are significantly below potential for stream-side vegetation and geomorphic stability. The Sprague River has been implicated in delivering a significant portion of the bound phosphorus load to the lake, primarily during peak runoffs (Gearheart, 1995). This is substantiated by the high correlation between flow rate and phosphorus loading (ODEQ, 2001). The relationship is evident even at low return interval flows, further indicating that unstable channel erosional inputs are a major contributor to phosphorous loading.

Restoration projects in the Sprague and Williamson watersheds have targeted flood-plain wetland and streamside riparian vegetation rehabilitation as a means to address issues of channel stability (bank erosion), riparian and stream habitat and thermal inputs to waterways. A major challenge in restoring stream channel function in the Sprague River is the amount of channel incision in smaller tributary streams, and major increases in width to depth ratios in the main-stem rivers. Initial observations and monitoring are encouraging. They include dramatic improvements in stream-side vegetation and substantial improvements in substrate composition, channel width, and bank stability. Most projects implemented to date have employed passive restoration techniques such as riparian fencing. Physical channel or flood-plain modifications have also been effective but they are often cost prohibitive or are inconsistent with landowner constraints or surrounding infrastructure.

Significant progress is anticipated to be made in the restoration of ecosystem function in the upper Klamath Basin over the next few years. There are many collateral restoration efforts ongoing in the upper basin. Federal efforts by the Forest Service, Bureau of Land Management, National Park Service, National Resources Conservation Service, and the Klamath Tribes have complimented those of USFWS and USBR. State agencies, such as OSU Extension, Oregon Department of Fish and Wildlife, Oregon Watershed Enhancement Board, and ODEQ have made major contributions to watershed improvements. For example fish passage, screening, and riparian fence projects in the Wood River area have largely been accomplished with state and private funding sources. In many cases KBERO program funds have been matched with other programs to further compliment restoration projects. The Klamath Soil and Water Conservation District, Lava Butte and Butte Valley Rural Conservation District are actively implementing water conservation and restoration projects. The Klamath Watershed Council was formed in 1997 to coordinate and assist local communities in restoration and water quality improvement efforts. The Upper Klamath Basin Working Group (UKBWG), a community advisory committee, was formed in 1995 to advise then Senator Mark O. Hatfield of issues relating to ecological restoration, reduction of drought impacts and economic conditions. Many private landowners have made individual efforts to improve watersheds and fish habitat. The UKBWG and KBERO have initiated a long range strategic planning process for restoration of the watershed and recovery of the two listed suckers. The collective actions of the entire basin are difficult to ascertain and quantify. Given recent congressional initiatives, it is likely that funding levels for restoration will increase substantially over the next ten years.

5.0 EFFECTS OF THE ACTION ON THE SHORTNOSE AND LOST RIVER SUCKERS

This section presents an analysis of the beneficial and adverse, direct and indirect effects of the proposed action, together with the effects of other activities that are interrelated or interdependent with that action, on the LRS and the SNS. The discussion below is combined for the LRS and SNS because their status, ecology, life history, distribution, and conservation needs are very similar.

5.1 Summary of Effects

1. Use of a 70% exceedance forecast to predict water-year types underestimates inflows in 7 out of 10 years, resulting in management to drier water-year types and lower lake levels more often than actual inflows would warrant.

2. The proposed action will increase lake depths in Project reservoirs above the hydrologic baseline during wetter water year types providing water quality benefits, but during drier year types depths will be reduced, likely exacerbating poor water quality conditions.

3. The proposed action, especially in dry and critically-dry water-year types, is likely to increase the frequency and magnitude of small-sized fish kills by increasing the number and extent of areas affected by pre-dawn DO declines during July-October.

4. Project dams increase storage of nutrient-rich storm inflows above the hydrographic baseline. These additional nutrients are likely to increase summer algal biomass in UKL, which adversely affects water quality and may lead to catastrophic fish die-offs similar to those that resulted in the loss of an estimated 80-90% of the adult sucker population in the 1990's, if certain environmental conditions exist. Such events are likely to be infrequent but have a high associated risk for suckers.

5. The proposed lake levels for UKL should provide stable or increasing depths and sufficient access by adult suckers to most of the shoreline spawning habitat during the three wetter year-types. However, under the lake level management proposed for the critically-dry water-year type, sucker spawning habitat will be limited and sucker reproduction will be reduced.

6. The proposed action will generally provide sufficient habitat for larval suckers in most water-year types. However, there is a high risk of larval year-class failure for the Williamson River spawning population of suckers as a result of lake level management proposed for the critically-dry water-year type.

7. The proposed action for UKL maintains summer/fall lake levels at or near the historic late summer baseline of 4140 ft for the above average water-year type, but lake levels drop substantially lower in August and October in the three drier water-year types and this is likely to result in a substantial loss of late-season juvenile sucker habitat in such years and poses a high risk of juvenile year-class failure in critically-dry years.

8. The proposed lake levels reduce late summer/fall adult sucker habitat by as much as 50% in

dry and critically dry years. Available adult habitat is further reduced by habitat limitations caused by areas of adverse or lethal water quality during the summer and fall when lake levels and habitat availability are at their lowest.

9. The proposed action provides minimum lake levels necessary to protect the viability of LRS and SNS populations in Clear Lake Reservoir and SNS populations in Gerber Reservoir (LRS not present).

10. The proposed action continues to provide very limited flows to sustain the few hundred individuals in the Tule Lake populations of the LRS and the SNS. Within Tule Lake, suckers will continue to be affected by adverse water quality conditions and very limited suitable habitat for adult suckers.

11. The proposed action will continue operation of the six primary Project dams, none of which provides suitable passage for suckers. The dams physically isolate sucker populations; prevent genetic exchange between populations; block access to essential spawning, larval, and rearing habitat; cut off escape from adverse conditions downstream; and prevent the return of entrained suckers to upstream habitat and spawning areas. The proposed fish ladder at the Link River Dam should allow spawning adults to pass the dam, but the smaller juvenile and sub-adults will remain isolated downstream where their survival will be reduced by poor water quality conditions.

12. Project water diversions, including dams and hydropower diversions, will entrain millions of larvae and tens of thousands of juveniles, and a few thousand sub-adult and adult suckers. This entrainment reduces the population of suckers and limits the amount of recruitment into the adult spawning populations. The screening of A-Canal by 2003 will reduce entrainment losses of juvenile, sub-adult, and adult suckers. However, entrainment of all life stages will continue to occur under the proposed action at the Link River Dam, as well as at other unscreened Project diversions. The number of suckers entrained at the Link River Dam and diversions is likely to increase if suckers that are bypassed from the A-Canal move a short distance downstream.

13. The proposed action will result in application of pesticides in the vicinity of sucker-occupied waterways. We consider pesticide use on private lands to be a potential threat to the LRS and SNS. This threat is minimized when pesticides are used according to label instructions and adequate buffer strips are used adjacent to open water or canals.

5.2 Effects of Water Management

Proposed water management at UKL, Clear Lake, Gerber Reservoir, and Tule Lake sump will affect the following conservation needs of the LRS and the SNS:

- The need to reduce the effects of poor water quality;
- The need to provide adequate habitat for all life-stages**;**
- The need to ensure recruitment; and
- The need to minimize competition with and predation by introduced fishes.

5.2.1 <u>70% Exceedence Forecast</u>

The use of a 70% exceedence to forecast water-year type will underestimate inflow predictions in 7 out of 10 years, resulting in management to drier year types more often than actual inflows would warrant. Under the proposed action, Reclamation would manage UKL elevations based on a forecast of how much water will be available for the Project during the 6-month irrigation season (April to October).
It does this using the following four-step process.

1) Every April, Reclamation forecasts inflows into UKL using snowpack data and known relationships between snowpack and inflow.

2) Next, Reclamation then applies an adjustment that is referred to as a "70% exceedence factor" to their predicted inflows.

3) Then the year is categorized into one of four categories (i.e., above average, below average, dry, and critically dry), known as "water year types," based on the inflow.

4) Finally, Reclamation refers to Table 5.1 in the BA to determine what UKL minimum lake levels would be, on monthly time steps, for a particular water year type. The drier the year type, the lower the lake is at the end of the summer, as shown below.

Water Year Type	September 30th Elevation(ft)
Above average	4139.8
Below average	4138.9
Dry	4138.2
Critically dry	4137.1

By using the 70% exceedence factor, Reclamation provides for a margin of error in its inflow estimates and ensures there will be adequate water for irrigation because 7 out of 10 years (70%) inflows will underestimated. However, by using the 70% exceedence factor, drier water year types are forecast more often then they would actually occur and wetter year types are forecast less often they would actually occur. As a result, UKL elevations would be lower more often than if water year types were actually based on inflows. For example, by using the 70% exceedance factor, Reclamation might forecast that a given year would be "dry" and would set the minimum September 30th elevation at 4138.2 ft. However, if the water year type was forecast based on actual inflows Reclamation might have found that the year type was actually "below normal," and would set the minimum September 30th elevation at 4138.9 ft. Thus, in this example the lake should have been 0.7 ft higher. Although this 0.7 ft difference may not seem significant, the average depth at the end of the summer is only about 6-ft deep. As a result, late summer, fall, and winter lake levels in some years could be as much as a foot lower than they would need to be. As will be discussed below, that 1-foot decrease in lake depth may be crucial to the survival and recovery of the suckers.

Reclamation has proposed to use the average lake levels for each water-year type during the decade of the 1990s as the reference for the proposed action. Water-year types have traditionally been based on historical inflows occurring from April to October in the period extending from October 1960 through September 1997 (USBR 2001). This 37-year period encompassed the time when existing Project features/facilities were completed, and it forms the basis of the water accounting spreadsheet model (KPOSIM) for the Project. For the 37-year record, net inflows for the four proposed water-year types (April to October) are presented in Table 5.2.1-1.

Table 5.2.1-1. UKL inflows (TAF) during the 37-year period of record (1960-1997) and historical frequency of occurrence for each year type.

	Water-Year Types			
Parameter	**Above Average**	**Below Average**	**Dry**	**Critically Dry**
Inflows (TAF)	>500	312–499	185-311	<185
Historical Frequency	19 (51%)	11 (30%)	5 (14%)	2 (5%)

Reclamation proposes to forecast inflows on the basis of 70% exceedence**;** meaning that 70% of the time inflows will actually be higher than predicted. The accuracy of Reclamation's April 1 inflow estimates based on the 37-year period of record is shown in Table 5.2.1-2. This table shows that using the 70% exceedence forecast underestimated the frequency of above-average year types, while overestimating below-average and dry-year types. Use of a 50% exceedence forecast improved the accuracy of the forecast.

Table 5.2.1-2. Frequency of water-year types based on actual measured inflows and April 1 forecasts for the 37-year period of record, 1960-1997 using 50% and 70% exceedences.

Water-Year Type	**Frequency of Actual Inflows**	**Inflows Based On 50% Exceedence**	**Inflows Based On 70% Exceedence**
Above Average	19	18	13
Below Average	11	11	15
Dry	5	7	7
Critically Dry	2	1	2

Assuming that the frequency of water-year types over the 10-year period of the proposed action are the same as they were over the 37-year period of record, the number of each year types that should occur is shown in Table 5.2.1-3. This table shows that by using the 70% exceedence forecast, the number of above-average years could be underestimated by 1.5.

Table 5.2.1-3. Predicted number of water-year types for the 10-year period of the proposed action, based on frequencies determined by the 37-year period of record (1960-1997), using actual inflows, and 50% and 70% exceedences.

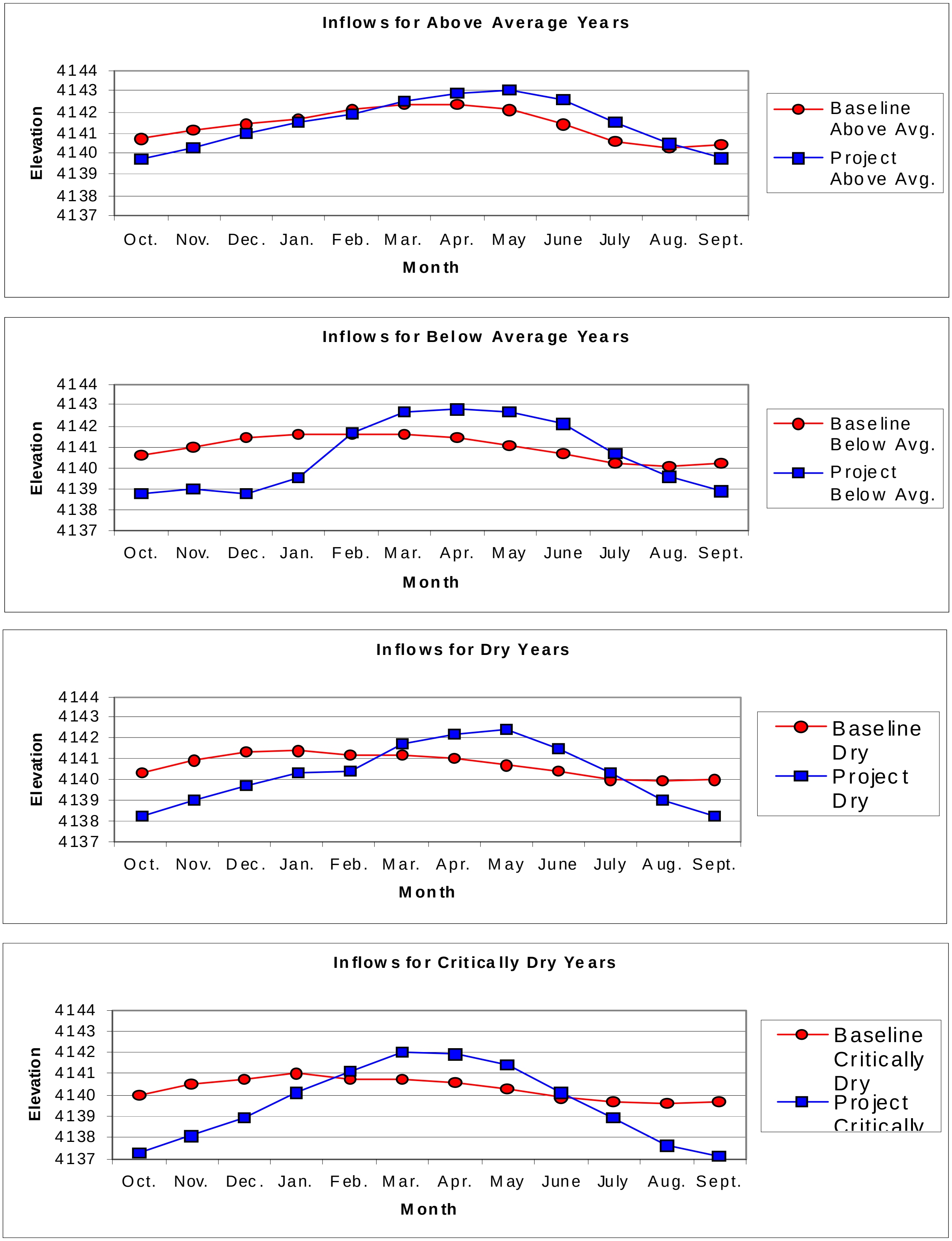
	Water-Year Type			
Exceedence	**Above Average**	**Below Average**	**Dry**	**Critically Dry**
Actual Inflow	5	3	1.4	0.5
50%	4.8	3.0	1.9	0.3
70%	3.5	4.0	1.9	0.5

For each water-year type, the minimum monthly lake levels that would result from the proposed action is presented in Table 5.2.1-4, and Figure 5.2.1-1 and is compared to the hydrographic baseline for each year type. Baseline hydrology for UKL, as it relates to the proposed action, represents the lake levels that would result if the Project did not store or divert water from the lake. It assumes that the Link River Dam is in place and includes the effects of reduced inflow caused by diversions upstream of UKL. The calculated lake elevations in this baseline approximate the natural hydrograph prior to construction of the dam, but are consistently about 4-6 inches lower on average, apparently because of upstream withdrawals. Determination of the current hydrologic baseline is based on modeling by Phillip Williams & Associates (2001).

Table 5.2.1-4. Upper Klamath Lake, end-of-month elevations (ft) by water-year types based on the hydrographic baseline and Reclamation's proposed action (Reclamation 2002b, Table 5.1).

Comparison of elevations resulting from the proposed action with the environmental baseline by water-year type and time step.						
Time Step	Above Average			Dry Year		
	Baseline elevation average	1990-1999 elevation average	Difference (feet)	Baseline elevation average	1990-1999 elevation average	Difference (feet)
October	4140.7	4139.7	-1.0	4140.3	4138.2	-2.1
November	4141.1	4140.3	-0.8	4140.9	4139.0	-1.9
December	4141.4	4141.0	-0.4	4141.3	4139.7	-1.6
January	4141.6	4141.5	-0.1	4141.4	4140.3	-1.1
February	4142.1	4141.9	-0.2	4141.2	4140.4	-0.8
March 1-15	4142.3			4141.2		
Mar. 16-31	4142.4	4142.5	+0.1	4141.2	4141.7	+0.5
April 1-15	4142.4			4141.1		
April 16-30	4142.4	4142.9	+0.5	4141.0	4142.2	+1.2
May 1-15	4142.2			4140.8		
May 16-31	4142.1	4143.1	+1.0	4140.7	4142.4	+1.2
June 1-15	4141.7			4140.5		
June 16-30	4141.4	4142.6	+1.2	4140.4	4141.5	+1.1
July 1-15	4141.0			4140.2		
July 16-31	4140.6	4141.5	+0.9	4140.0	4140.3	+0.3
August	4140.3	4140.5	+0.2	4139.9	4139.0	-0.9
September	4140.4	4139.8	-0.6	4140.0	4138.2	-1.8
Time Step	Below Average			Critical Dry		
	Baseline elevation average	1990-1999 elevation average	Difference (feet)	Baseline elevation average	1990-1999 elevation average	Difference (feet)
October	4140.6	4138.8	-1.8	4140.0	4137.3	-2.7
November	4141.0	4139.0	-2.0	4140.5	4138.1	-2.4
December	4141.5	4138.8	-2.7	4140.7	4138.9	-1.8
January	4141.6	4139.5	-2.1	4141.0	4140.1	-0.9
February	4141.5	4141.7	+0.2	4140.7	4141.1	+0.4
March 1-15	4141.6			4140.7		
March 16-31	4141.6	4142.7	+1.1	4140.7	4142.0	+1..3
April 1-15	4141.5			4140.6		
April 16-30	4141.5	4142.8	+1.3	4140.6	4141.9	+1..3
May 1-15	4141.3			4140.4		
May 16-31	4141.1	4142.7	+1.6	4140.3	4141.4	+1.1
June 1-15	4140.9			4140.1		
June 16-30	4140.7	4142.1	+1.4	4139.9	4140.1	+0.2
July 1-15	4140.4			4139.8		
July 16-31	4140.2	4140.7	+0.5	4139.7	4138.9	-0.8
August	4140.1	4139.6	-0.5	4139.6	4137.6	-2.0
September	4140.2	4138.9	-1.3	4139.7	4137.1	-2.6

Figure 5.2.1-1. Upper Klamath Lake Inflows for Year Types.



5.2.2 Upper Klamath Lake

The effects of water management on suckers in UKL can be separated into two categories: (1) effects on water quality; and (2) effects on habitat availability.

Effects on Water Quality

The proposed action will alter the UKL hydrograph, impacting the frequency and severity of adverse water quality conditions that are potentially lethal to suckers. A variety of hypotheses have been discussed under the Environmental Baseline section of this document to explain the relationship between water quality and management of UKL levels. As discussed therein, the best available information supports the hypothesis that low lake levels exacerbate poor water quality conditions during the late summer and fall, especially in dry and critically dry water-year types, by increasing the number and extent of areas affected by pre-dawn declines in DO; this effect is likely to increase the frequency and/or magnitude of small-sized fish kills. Based on the findings of Wood (2002), large, potentially catastrophic fish kills also may result from lake management that involves the storage of nutrient-rich runoff from periodic spring flood events which supports the production of large *AFA* biomass in the summer. While such events are likely to be infrequent, they have a very high associated risk of catastrophic sucker mortality.

A more detailed analysis of the effects of adverse water quality is presented in Appendix E. Since water quality is one of the most critical factors affecting sucker survival and recovery, the reader is encouraged to review this material which is summarized below.

The primary concern regarding the effect of the proposed action on water quality in UKL is the affect lake depth (represented by lake levels) has on water quality, especially as it relates to conditions leading to catastrophic fish kills.

In UKL, water quality poses the greatest risk to suckers during the period from July to mid-October and has caused massive fish kills as recently as 1997 (Kann 1998; Wood et al. 1996; Perkins et al 2000b; Loftus 2001; Welch and Burke 2001). Although a number of water quality parameters regularly reach levels known to be stressful or lethal to suckers and other fish (e.g., pH, un-ionized ammonia, DO), low DO appears to be the primary cause of death (Martin 1998; Martin and Saiki 1999; Perkins et al 2000b; Loftus 2001; Welch and Burke 2001). When conditions are right (primarily a high biomass of decomposing *AFA*, warm temperatures, and calm winds), shallow areas of the lake are subjected to stressful or lethal pre-dawn DO declines. The threat is greatest in shallow depths (<3 ft) because the ratio of sediment surface area to water column volume is highest (Miranda et al. 2001). The sediment oxygen demand (SOD) can reduce DO levels in the water column to lethal levels in a few hours. This situation can be exacerbated by decomposing *AFA* in the water column, which can have a similar oxygen demand to the sediment. If calm periods last for several days, the lack of mixing by wind could worsen low DO conditions in shallow water and larger and deeper areas could be affected. The effect of pre-dawn DO sags in shallow water would be exacerbated by wind-driven patches of decomposing *AFA*, whose respiration and that of any associated bacteria, would increase DO demand. Poor water quality adversely affects fish, causing stress, reduced fitness, and reduced reproductive potential, even at non-lethal levels (Perkins et al 2000b; Reiser et al. 2001; Loftus

2001). However, small-sized fish kills are regularly reported in UKL during the late summer, indicating that adverse water quality reaches lethal levels at some spatial scale nearly every year.

Large, catastrophic fish die-offs, involving tens of thousands of adult suckers, occur periodically in UKL, most recently in 1995, 1996 and 1997 (Perkins et al 2000b; Loftus 2001; Welch and Burke 2001). Wood (2002) suggested that these catastrophic die-offs may be triggered by nutrient-rich runoff in spring during flood conditions that are large enough to flush sediments and nutrients into the lake. Such events could lead to large *AFA* blooms, which in turn would produce larger, catastrophic declines in water quality later in the summer. This is most likely to be a problem during a year with an exceptionally high run-off event. Such events appear to have recurrence intervals of 5-20 years. If nutrient-rich run-off is stored in the lake, rather than allowed to pass through the lake, this type of condition is likely to contribute to adverse water quality conditions. This is more likely to occur under the proposed action because more water is retained in the lake in the spring than under the hydrographic baseline. In comparison to the hydrologic baseline, the proposed action draws the lake down lower in late summer and then fills it higher in the spring (see Figure 5.2.1-1 above). This maximizes storage of run-off and any associated nutrients. *AFA* blooms in June appear to be stimulated by these nutrients, as a result their biomass can be elevated to levels that later in August maximizes the risk of low DO conditions as the blooms decompose.

Shallow lake depths in UKL could also have adverse effects in the winter (January to March) as DO concentrations decline and un-ionized ammonia concentrations might increase during prolonged (several month) ice-cover conditions that prevent surface reaeration. However such conditions appear to be unlikely because prolonged ice-cover events are rare.

Effects of Above-Average Water-Year Type. The above-average water-year type is predicted to occur in about four out of the 10 years of the proposed action (Table 5.2.1-3). Lake elevations in above average water-year types are similar to or higher than the hydrographic baseline condition for most of the year (Figure 5.2.1-1) on that basis, we do not anticipate adverse effects to water quality in most years.

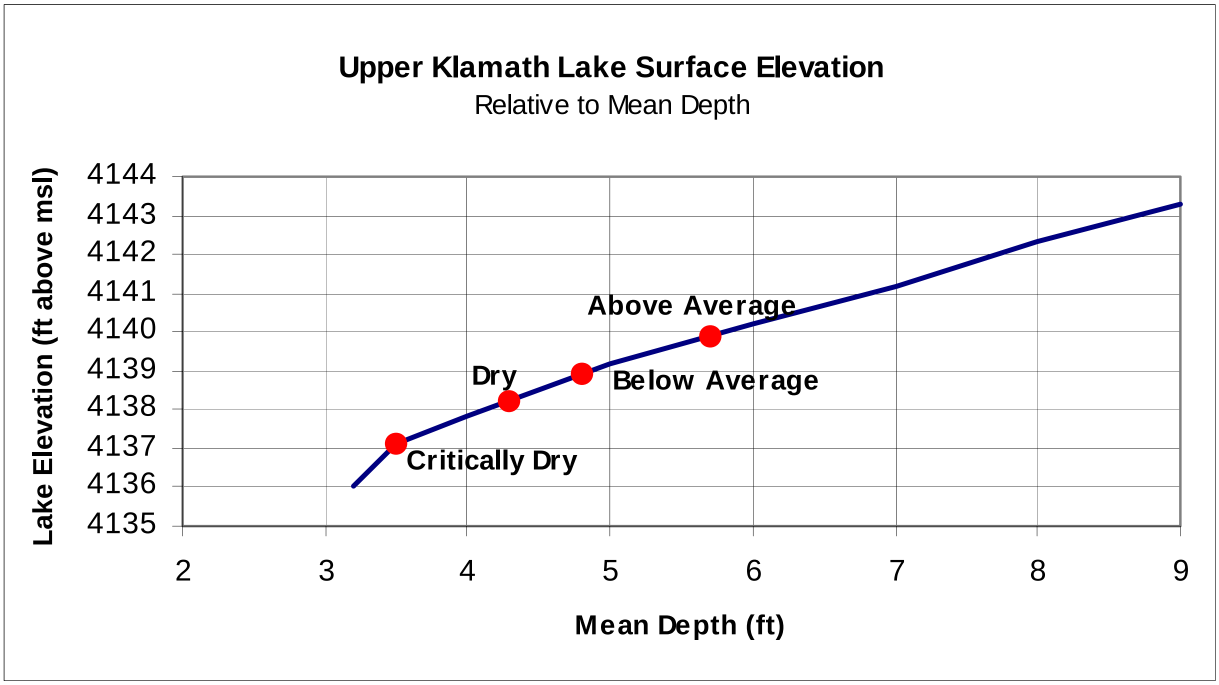
Notwithstanding the potential adverse effects of storing nutrient-rich runoff in the spring during flood conditions, some water quality benefits are provided by the proposed action because April through July lake elevations are above hydrographic baseline levels. In most years, higher lake levels are likely to reduce *AFA* production through a variety of potential mechanisms discussed under the Environmental Baseline section and in Appendix E, as well as improve DO levels.

If the above average water-year type occurs at a greater frequency than predicted, the Service does not anticipate adverse effects to suckers because lake water quality is likely to be better in response to greater lake depths with the exception in years with unusually high spring run-off events, as discussed above.

Effects of Below Average Water-Year Type. The below-average water-year type is predicted to occur in about 4 of the 10 years of the proposed action (Table 5.2.1-3). Lake elevations in this water-year type are similar to or higher than hydrographic baseline conditions for the March to July period, but elevations are below the hydrographic baseline levels from September to

February (Figure 5.2.1-1) . In September**,** the proposed lake elevations reach 4138.9 ft. At this elevation, the mean depth of the lake is about 5 ft (Figure 5.2.2-1). At such a depth, there are significant areas of the lake where water depths are less than 3 ft**;** these areas would be at risk of pre-dawn DO sags. The resultant adverse water quality conditions could lead to sucker mortality, especially of juvenile suckers that reside in shallow water. There also is some risk to suckers under this shallow depth condition associated with prolonged ice cover in winter but the risk appears low because a prolonged ice cover condition is not likely to occur at UKL.

Figure 5.2.2-1. The relationship between UKL water surface elevation and mean water depth. Also shown are the September 30th elevations for the four water year types.



If the below average water-year type occur**s** at a greater frequency than predicted, the risk to suckers from lower lake depths would be increased. The level of risk would likely depend on the resultant lake depths which cannot be predicted.

Effects of Dry Water-Year Type. This year type is predicted to occur in about 2 of the 10 years of the proposed action (Table 5.2.1-3). Lake elevations in this water-year type are similar to or higher than hydrographic baseline conditions for the March to July period, but elevations are below the hydrographic baseline from August to February (Figure 5.2.1-1). During this year type, lake elevations from August to mid-October will be reduced to 4138.2 ft, and the mean depth of the lake will be just over 4 ft (Figure 5.2.2-1). At such a depth, there are significant areas of the lake where water depths are less than 3 ft**;** these areas would be at risk of pre-dawn DO sags. The resultant adverse water quality conditions could lead to sucker mortality, especially of juvenile suckers that reside in shallow water. Adverse conditions in shallow water could spread to deeper water if low DO conditions worsen, which would likely result in adult sucker mortality. Potential fish kill conditions are highest in August**,** and start to decline in September. Adverse effects could also occur in the winter (January to March) as DO concentrations decline and un-ionized ammonia concentrations increase during prolonged ice-cover conditions. However, this risk is low because a prolonged ice cover condition is not likely to occur at UKL.

If the dry water-year type occurs at a greater frequency than predicted or occurs after a critically dry water year, the risk of adverse effects to suckers described above would be increased. However, based on the period of record, the probability of back-to-back dry water years or critically dry water years is low. Although there are multi-year wet and dry periods in the historical record of precipitation, water-year types within those periods appear to occur in a random manner.

Critically-Dry Water-Year Type. This water-year type is predicted to occur in about one (0.5) of the 10 years of the proposed action (Table 5.2.1-3). Lake elevations in the critically dry water-year type are similar to or higher than the hydrographic baseline conditions (Figure 5.2.1-1) from February to June, but lake elevations are below the hydrographic baseline from July to February, and by the September/October period they are 2 ft or more below the hydrographic baseline. During the critical August to mid-October period when water quality is likely to be most severe, lake elevations are below 4138 ft, going as low as 4137.1 ft, and the mean depth of the lake ranges from about 3.5 to 4 ft (Figure 5.2.2-1). Since one-third to nearly on-half of the lake is under 3 ft, the risk of small-sized fish kills due to DO sags is likely to be high. Also, because so much of the lake is at the depth where DO sags are most likely to occur (<3 ft), adverse conditions in shallow water could spread into deeper water. The result could be larger and more frequent fish kills and could include a greater number of adult suckers, who reside in deeper water. Factors likely determining the size of fish kills are condition of *AFA*, and wind speed and the extent of surface re-aeration. An abundance of decomposing *AFA* would exacerbate low DO conditions. Low winds can lead to severe water quality conditions in a few hours to days. Adverse effects could also occur in the winter (January to March) as DO concentrations decline and un-ionized ammonia concentrations increase during prolonged ice-cover conditions. However, this risk is low because a prolonged ice cover condition is not likely to occur at UKL.

Also, during critically-dry water years, any water quality benefits that emergent marsh habitats might provide to sucker larvae and juveniles would be lost as lake levels recede below the level of the marshes (4140 ft) and the fish must enter the lake proper where water quality is likely to be worse. This occurs in late June just after most larvae have transformed into juvenile suckers. This is a crucial period since fish at this stage are relatively vulnerable to predation, starvation, and other factors.

If the critically-dry water-year type occurs at a greater frequency than predicted or occurs immediately following one or more dry water years, the risk of adverse effects to suckers described above is likely increased. In addition to mortality, suckers are likely to be stressed and their fitness reduced, making them more vulnerable to disease, parasites, and predators. Although, the probability of a critically dry water year following one or more dry years is low, the risk such events pose to suckers could be significant and fish kills, if they occur, may be catastrophic.

Effects on Habitat Availability

The proposed water management at UKL will affect the habitat available to each of the life-stages of the suckers, including larvae, juveniles, sub-adults, and adults. Each life-stage has different habitat needs and different critical seasons when they use that habitat (Figures 5.2.2-2 and 5.2.2-3).

Figure 5.2.2-2. Presence of critical lifestages in UKL by month. It is important to note that larval and first year young-of-the-year juveniles are only present during certain months.

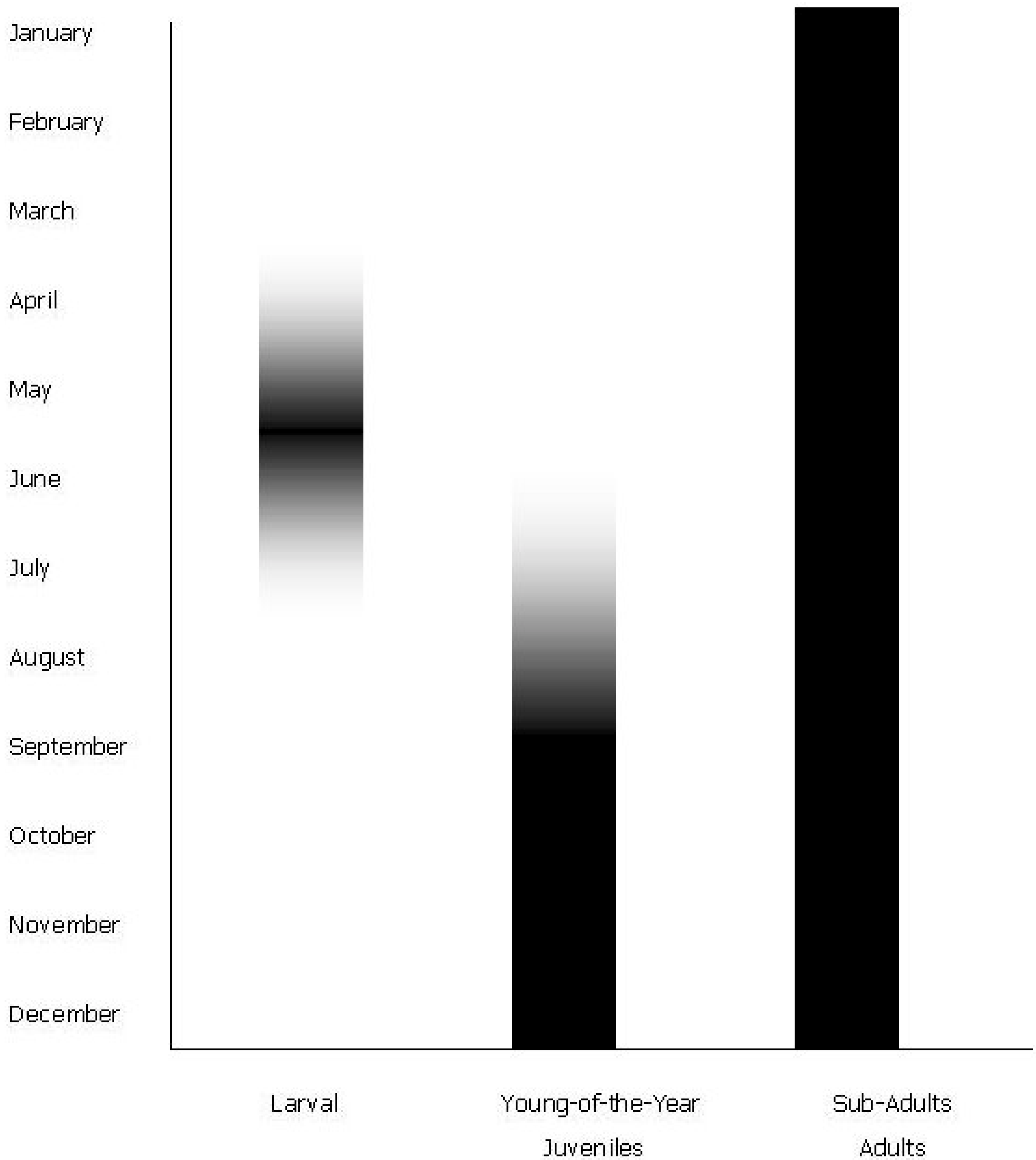
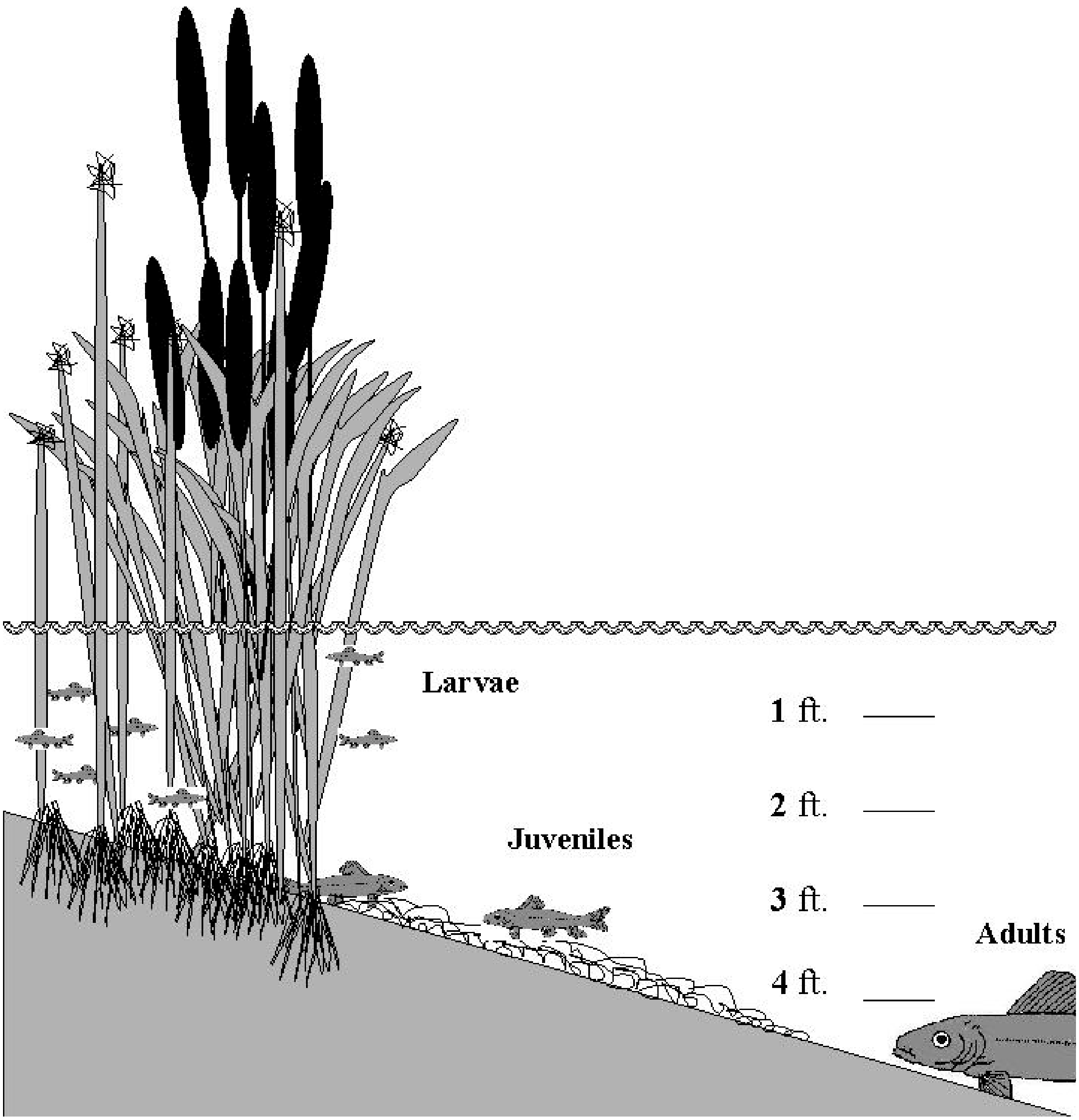


Figure 5.2.2-3. Simplified Schematic of Habitat use by different sucker life-stages.



Shoreline Spawning Habitat (February-May). The proposed lake levels should provide stable or increasing water depths and sufficient sucker access to most of the spawning habitat in UKL (using Sucker and Ouxy Springs as representative spawning areas) during the three wetter water-year types (Tables 5.2.2-1 and 5.2.2-2). Water depths in these water-year types are higher than the hydrographic baseline in all months except February (for above-average and dry water-year types). In critically-dry water years, sucker spawning habitat will be limited and descending lake levels will probably result in loss of reproduction from the shallower portions of the spawning areas. Higher water levels in any water-year type will further enhance sucker spawning habitat and is likely to improve spawning success.

Suckers spawn at specific sites within UKL, primarily near eastern shoreline springs with a gravel substrate (Andreasen 1975; Buettner and Scopettone 1990; Hayes and Shively 2001; Shively et al. 2000). Along the eastern shore of UKL, likely spawning occurs at Sucker, Silver Building, Ouxy, and Boulder springs, and Cinder Flats (a non-spring site). Sucker spawning areas in UKL contain relatively clean gravel substrates where eggs are broadcast or slightly buried (Buettner and Scoppettone 1990, 1991; Perkins and Scoppettone 1996; Perkins et al. 2000a). The accessibility of spawning gravels with sufficient water depth for adult suckers is crucial to spawning success in the lake and survival of the lake spawning populations (Reiser et al. 2001). Shoreline sucker spawning can start as early as February and extend through May (Perkins et al. 2000a; Reiser et al. 2001; Shively et al. 2000a).

In 1995, the Klamath Tribes conducted an intensive sucker spawning survey at Sucker Springs (Reiser et al. 2001). This survey documented sucker spawning in water depths of 0.6-3.8 ft. However, over 95% of the sucker embryos were found at depths of 1.0-3.5 ft. The limits of the spawning area are at a lake elevation of about 4139.0- 4141.5 ft at Sucker Springs and 4139.5-4142.5 ft at Ouxy Springs. Therefore, minimum lake levels to submerge these two spawning areas to a depth of at least one foot would be 4142.5 and 4143.5 ft, respectively. Tables 5.2.2-1 and 5.2.2-2 present estimates of the percentage of sucker spawning substrate that is inundated to a depth of at least one foot at the two springs at various lake levels. Information on sucker spawning area depth and extent is not available for other spawning areas in the lake.

Table 5.2.2-1. Approximate percent of sucker spawning habitat submerged to at least one foot at Sucker and Ouxy Springs at various lake levels.

	Percent of Spawning Habitat Submerged at Least 1 Foot	
Lake Level (ft)	**Sucker Springs**	**Ouxy Springs**
4142.5	100 %	70 %
4142.0	68 %	43 %
4141.5	46 %	32 %
4141.0	28 %	14 %
4140.5	10 %	0 %

Table 5.2.2-2. Proposed lake levels during each of four water-year types during months when lakeshore spawning is likely to occur. The lake levels needed to submerge Sucker and Ouxy Springs completely to a minimum depth of 1 foot are 4142.5 and 4143.5 ft, respectively.

	Proposed Lake Elevations (+4100 ft) in Different Year Types			
Month	**Above Average**	**Below Average**	**Dry**	**Critically Dry**
Feb	41.9	41.7	40.4	41.1
Mar	42.5	42.7	41.7	42.0
Apr	42.9	42.8	42.2	41.9
May	43.1	42.7	42.4	41.4

Larval Sucker Habitat (April-July). The proposed action maintains lake levels during April-July above the hydrographic baseline in all months and water-year types, except during July of critically-dry water years. Proposed May 31 lake elevations generally provide sufficient larval habitat, determined by habitat availability and historic juvenile year-class production, in all year classes except during critically-dry water years. Proposed lake elevations in July severely limit larval habitat, except in above-average water years. In critically-dry water years the proposed lake levels will not provide emergent habitat during June and July. There is a high risk of year-class failure for the Williamson River spawning population of suckers in critically-dry water years for the reasons discussed below.

Larval suckers primarily emigrate from the Williamson River to UKL during May and June, and larvae, including those produced at lake shoreline and tributary stream spawning areas. Larvae are generally present in UKL from April through July (Cooperman and Markle 2000; Simon et al. 1996; Simon et al. 2000b). Larval habitat in UKL is generally near shore in water less than about 20 inches (50 cm**)** deep and associated with emergent aquatic vegetation (Buettner and Scoppettone 1990; Markle and Simon 1994; Klamath Tribes 1995, 1996; Cooperman and Markle 2000; Reiser et al. 2001). Emergent aquatic vegetation provides suckers cover from predation, protection from currents and turbulence caused by wind and wave action, and a higher availability of food (Klamath Tribes 1996). Water quality in these areas may also be better than in the open areas of the lake where *AFA* blooms radically alter diurnal DO and pH levels.

It is believed that sucker larvae emigrating from the Williamson River generally move east and then south along the shoreline. Due to the large numbers of spawning adult suckers in the Williamson River, the area around the river mouth and in nearby Goose Bay is considered to provide crucial nursery habitat for sucker larvae. Dunsmoor et al. (2000) quantified potential larval habitat adjacent to the Williamson River mouth to assess how changes in lake pool elevation and shoreline morphology influence distribution and availability of habitats provided by emergent vegetation (see Table 5.2.2-3).

Table 5.2.2-3. Percent of sucker larval habitat available in each of four water-year types during months when sucker larvae are present in (A) Lower Williamson River and (B) Goose Bay (percent total emergent habitat underwater; adapted from Dunsmoor et al. 2000).

Month	Percent of Larval Habitat Available in Different Water-Year Types			
	Above Average	Below Average	Dry	Critically Dry
A)	**Lower Williamson**			
Apr	78 %	73 %	42 %	29 %
May	89 %	67 %	52 %	13 %
June	62 %	37 %	15 %	0 %
July	15 %	1 %	0 %	0 %
B)	**Goose Bay**			
Apr	86 %	81 %	59 %	48 %
May	93 %	78 %	67 %	30 %
June	76 %	55 %	34 %	3 %
July	34 %	11 %	6 %	0 %

Based on sucker larval needs for emergent vegetation (i.e., cover, predator avoidance, and feeding), the Klamath Tribes (1995) recommended that water level elevations at Goose Bay, east of the Williamson River mouth, meet 4142.6 ft at the end of May and 4141.6 ft on July 15, inundating 70% and 28% of emergent habitat, respectively. A similar conclusion was reached in an analysis of juvenile year-class strength versus May 31 lake elevation (Reiser et al. 2001). From 1988-1999, strong juvenile year-classes were apparently established in 8 of 10 years when May 31 elevation exceeded 4142.4 ft. Poor year-class indices were documented in 1992 when the May 31 elevation was 4140.7 ft. Essentially no emergent vegetation remains along UKL shorelines at 4140.0 ft and lake elevations below that level.

Juvenile Habitat (July-October). The proposed action maintains lake levels during July-October at or near the historic late-summer hydrographic baseline of 4140 ft in above average water years, but drops substantially lower during August-October of the three drier water-year types (Figure 5.2.1-1). At lake elevations below 4140 ft, essentially no emergent vegetation remains for juveniles (Table 5.2.2-4). However, suitable rocky substrates are available, though reduced, at 4138 ft in the dry water-year type. The percentage loss of rocky shoreline habitats at lower lake elevations is not known, but it is likely that rocky habitat become scarce as lake levels decline. There is a substantial loss of late-season juvenile sucker habitat and a high risk of year-class failure in critically-dry water years due to shallow lake depths during August-October.

Table 5.2.2-4. Proposed lake levels during each of four water-year types during months when age 0 juvenile suckers are using shoreline habitats. At 4140 ft (shaded) no emergent habitat remains. The depth distribution of rocky submerged habitat used by age 0 suckers is not presently known.

	Proposed Lake Elevations (+ 4100 ft) in Different Year Types			
Month	**Above Average**	**Below Average**	**Dry**	**Critically Dry**
June	42.6	42.1	41.5	40.1
July	41.5	40.7	40.3	38.9
Aug	40.5	39.6	39.0	37.6
Sept	39.8	38.9	38.2	37.1

Juvenile suckers (age 0) primarily use rocky substrates (i.e., gravel and cobble) in unvegetated shoreline areas of UKL and use emergent vegetation where available (Klamath Tribes 1996; Cooperman and Markle 2000; Reiser et al. 2001; Simon and Markle 2001; VanderKooi 2002). OSU mapped the shoreline distribution of habitat types in UKL during the 1994 low lake period (Simon et al. 1994, upub. data). The majority of suitable rocky habitats occur in the southern two-thirds of the lake, with almost none in the north or northeast, where emergent vegetation is crucial to larval and juvenile suckers.

The depth distribution of rocky substrates is not known, so no determination of habitat loss due to lower lake levels can be made. However, rocky substrates probably only extend about 60 to 100 ft (20-50 m) offshore, and the shallow slopes of most shoreline areas suggest that below a lake elevation of 4138 ft, little rocky substrate may remain (Simon et al. 1995). Depth distribution data are available for emergent vegetated habitat, and at 4140 ft, essentially no emergent vegetated habitat is available to juvenile suckers in the rearing grounds at the northeast corner of UKL (Dunsmoor et al. 2000; VanderKooi 2002). VanderKooi (2002) found that catches of juvenile suckers dropped off dramatically in late August coinciding with the lake level dropping below 4140 ft. Although age 0 juvenile suckers occupy a wider range of habitats and are less susceptible to predation than larvae, lowering lake levels ultimately forces juvenile suckers from emergent habitats into open areas of the lake, where food and cover are less available and water quality is generally worse, and may further increase the risk of entrainment as these fish search for suitable habitat (Simon et al. 1996; Klamath Tribes 1996).

Adult Habitat (July-October). The proposed lake levels reduce late summer/fall adult sucker habitat by as much as 50% in dry and critically dry water-year types (Table 5.2.2-5). Available adult habitat is further reduced by habitat limitations caused by areas of adverse or lethal water quality during the summer and fall, when lake levels and habitat availability are at their lowest. The Service assumes that as water depths decline, particularly under adverse water quality conditions, the availability of suitable habitat decreases, and suckers may be forced to choose between seeking adequate depth cover and adequate water quality. It is crucial to maintain UKL

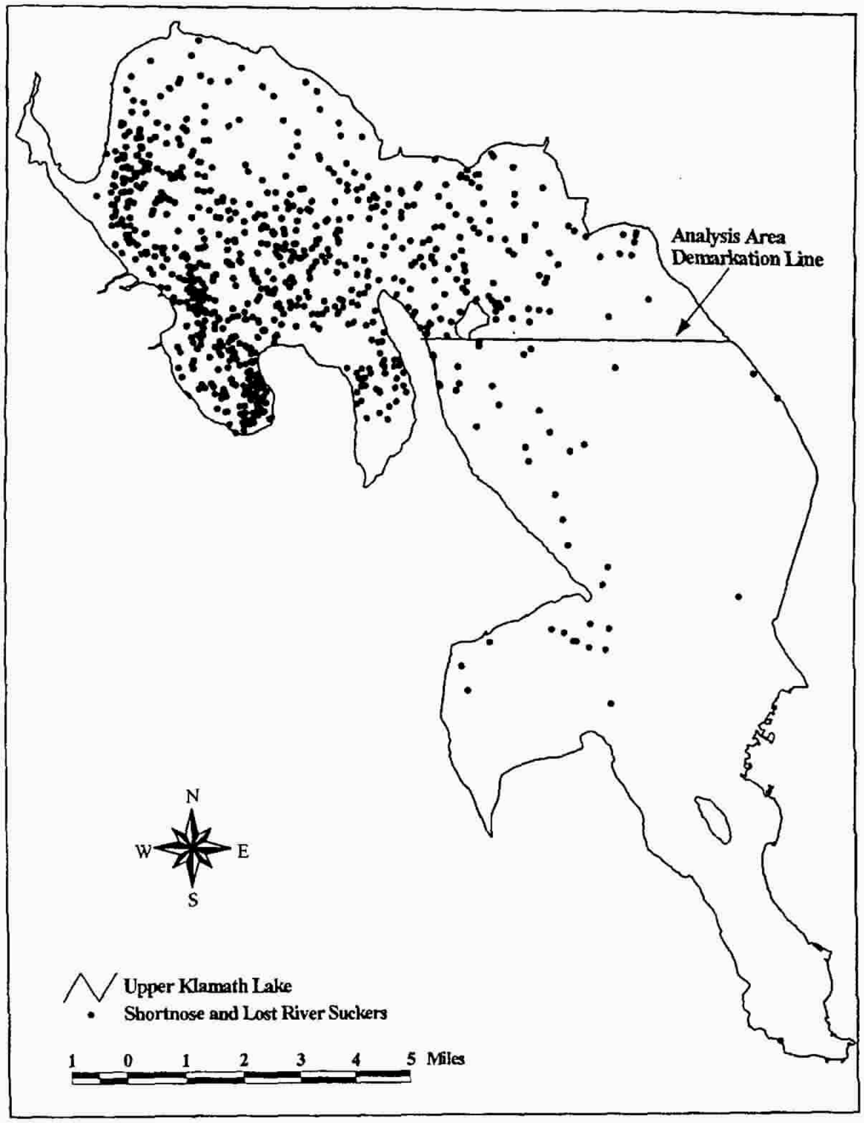
levels sufficiently high from August to
mid-October to ensure suckers have adequate access to refuge areas and can move freely between areas of appropriate depth to avoid localized adverse water quality conditions.

Table 5.2.2-5. Percent of September hydrographic baseline habitat (assuming 4140 ft elevation) available at lake levels as proposed for the various water-year types.

			Water-Year Type			
	Full Pool	Baseline Sept.	Above Average	Below Average	Dry	Critically Dry
Proposed Lake Level (ft)	4143.3	4140	4140	4139	4138	4137
Adult Habitat (acres)	25,000	20,000	20,000	16,000	13,000	10,000
Percent of Baseline Habitat	128%	100%	100%	83%	66%	48%

Adult suckers are mostly found in the northern portion of the lake (Reiser et al. 2001, Simon 2000a,USBR 2000d; Figure 5.2.2-4). They are bottom-oriented, consistently swim less than 1 ft above the bottom, and show a strong preference for water depths over four feet. The critical minimum acceptable habitat depth for adult suckers is apparently 3 ft; however they show greater selection of depths over 4 ft, when available.

Figure 5.2.2-4. The distribution of radio-tagged adult shortnose and Lost River suckers in Upper Klamath Lake, 1993 through 1998, between April and December of each year (lake level elevation range from 4,143 to 4,136.9 ft msl). Adapted from Reiser et al. 2001, Figure 3-3.



This analysis uses available habitat calculations from Reiser et al. (2001), which differ somewhat from Reclamation's analysis (USBR 2002), due to Reiser et al. constraining their analysis to the area north of Bare Island, where most suckers occur during August/September period (Figure 5.2.2-4). At full pool elevation (4143.3 ft), about 25,000 acres of adult sucker habitat (at depths of 3-15 ft) are present in the occupied northern portion of the lake. The minimum hydrographic baseline elevations occur in August/September and are near 4140 ft (Figure 5.2.1-1). At this level, about 80 % of adult sucker habitat (>3 ft) is available. Proposed lake levels are expected to drop below 4140 ft in August and September during all water-year types except above-average, when they would drop just below 4140 ft (4139.8 ft) in September only (Figure 5.2.1-1). September lake levels would drop substantially lower in below-average (4138.9 ft), dry (4138.2 ft) and critically-dry (4137.1 ft) water-year types. In 1994, lake levels dropped to 4137 ft and adult suckers appeared to survive the summer without a major die-off caused directly by low lake levels. However, the condition of adults examined was poor, and if conditions affecting water quality had different, large fish kills may have occurred.

The availability of habitat within the depth range used by adult suckers is substantially reduced at the proposed lower lake levels. Furthermore, as lake levels drop, the habitat at 3-6 ft depths increases while the preferred habitat at 6-9 ft depths is reduced in relative availability. As noted above**,** depths of 3-4 ft appear to be only infrequently used by adult suckers. Therefore, habitat estimations based on a 3 ft. minimum should be considered marginal, and maintaining lake levels higher to provide increased habitat of 4 ft or deeper would be more appropriate. Available habitat is further reduced by habitat limitations caused by areas of adverse or lethal water quality during the summer and fall, when lake levels and habitat availability are at their lowest.

In summer, adult suckers frequently use areas of UKL influenced by higher water quality stream and spring inflows (USBR 2000d; USBR 1996a; Reiser et al. 2001). Adult suckers apparently avoid shallow, clear water except when showing ill effects of poor water quality. The need to seek adequate depth in UKL may make adult suckers more vulnerable to the adverse effects of poor water quality because they appear to avoid inflow areas where the water quality is high if there is a lack of cover owing to shallow depths and relatively high water clarity, and appear to remain in deeper areas where water quality is generally worse during July-October.

As lake levels decline below 4140 ft, the area deeper than 3 ft moves farther from inflow sources, until at an elevation of 4138 ft, it is about 0.5 mi east of Pelican Bay. There are also areas with shallow depths of about 3 ft that may limit connectivity between deeper habitat areas of higher water quality. The distribution of water quality refuge areas within the lake is dynamic and poorly understood, once the water moves away from the input source. The farther higher quality water travels, the less likely it will serve as a refuge, since it will be diluted with water of poorer quality and altered in transit over shallow areas. This would especially be the case if an *AFA* bloom was present in the area.

5.2.3 <u>Clear Lake Reservoir</u>

Effects on Habitat Availability and Water Quality

The proposed action provides minimum lake levels that will allow the LRS and the SNS to successfully spawn and recruit new age classes into the adult population. The proposed lake levels in spring should allow access to spawning areas in tributary streams (Willow Creek) and provide shallow, flooded habitats that provide cover for larvae and age 0 juvenile suckers. Because of the high turbidity and relatively low concentrations of nutrients *AFA* blooms are not an issue at Clear Lake and water quality is better than at UKL or Gerber Reservoir.

The primary threat to LRS and SNS populations in Clear Lake is an extended drought that would result in very low lake levels that would, in turn, result in large fish kills during the late summer and fall, as well as fish kills in the winter during prolonged ice-cover conditions. The proposed minimum lake elevations are anticipated to provide adequate protection from such conditions in most years. However, lake levels will need to be monitored to ensure that lake levels do not drop below minimum requirements, especially during multi-year droughts. During drought conditions the lake level will continue to decline as a result of evaporation and seepage, even if no water is released. If the lake level at the beginning of a drought is low, lake levels the next year may be even lower, and the lake could go dry in consecutive drought years. Reclamation has developed a reservoir operations model for Clear Lake from which future storage can be predicted based on previous inflow and stage relationships and outflow (Service 1994b). Based on the period of record, the model indicates a very low probability of consecutive dry years and little chance of the lake going dry if proposed minimums are met in the preceding year and additional water release is controlled to ensure that subsequent minimums are maintained.

Although we do not anticipate significant mortality events at Clear Lake as a result of the proposed action, there will be a significant loss of larval, juvenile, and adult sucker habitat each year as lake level fluctuates, with resulting adverse effects to the suckers due to increased competition for food, higher predation and reduced fitness. Summer lake levels below 4524 ft substantially reduce juvenile and adult sucker habitat, probably leading to increased competition for food, higher predation and reduced fitness (USBR 2002). The minimum summer lake elevations proposed by Reclamation (USBR 2002**:** Table 5.7) remain above 4524 ft in the three wetter water-year types, except for August and September of the dry water-year type, where they are near this level (4523.5 - 4522.8 ft). In the critically-dry water-year type the level of Clear Lake would drop more than 3 ft lower (4520.6 ft). The Service assumes this elevation would occur in no more than two out of 10 years and not in consecutive years.

The effects of fluctuating water elevations at Clear Lake on the resident sucker populations in terms of population size, age-class distribution, recruitment, or decreased fitness are not fully understood. However, available information indicates that the Clear Lake sucker populations have remained viable under the current management regime (see the discussion of Clear Lake under the “Status of the Species” section).

Sucker access into Willow Creek, the principal spawning tributary, requires a minimum spring (February through April) elevation at Clear Lake of 4524 ft. The minimum proposed elevation for this period is 4524.6 ft in the critically dry water-year type. Thus, the proposed action is anticipated to provide adequate water depths for sucker spawning access to Willow Creek in all water-year types.

Minimum lake levels are required in high elevation, shallow lakes such as Clear Lake to reduce the threat of low DO levels under an ice cover. In October 1992, the water surface elevation of Clear Lake was 4519.2 ft before the onset of a hard winter, and no fish kills were observed, although suckers showed poor condition factors in the subsequent spring. Accordingly, the Service assumes that 4519.0 ft is the minimum October surface elevation at which the sucker populations can survive through the winter. The minimum proposed elevation for the winter period (October-February) is 4520.4 ft in the critically dry water-year type. Thus, the proposed action is anticipated to provide adequate water depths for protection against winter-kill of suckers in all water-year types.

Following the irrigation season, flow to the Lost River below Clear Lake is essentially cut off, leaving only a few cfs leakage. Until accretion flows increase in mid-winter, the dewatered reach of the river may be as much as 8 miles long. Fish, including suckers, apparently seek refuge in the remaining shallow pools. During annual salvage operations near the dam small numbers of LRS and SNS are collected from pools below the dam. DO in the pools generally is low owing to relatively high concentrations of aquatic organisms and from those dying in the vicinity of the pool. The survival of suckers and other fish in these pools through the winter is questionable due to DO depletion, which is exacerbated by ice cover, and increased predation. Large numbers of aquatic insects, snails, and mussels are often found dead in the pools. The new Clear Lake dam will be equipped with both an operational fish screen and gates to effectively provide a minimum flow. A minimum flow of approximately 10 cfs will improve water quality in this reach and will reduce sucker habitat loss and degradation associated with the historic dewatering of this reach.

5.2.4 Gerber Reservoir

Effects on Habitat Availability and Water Quality

The proposed action provides minimum lake levels that will allow the SNS to successfully spawn and recruit new age classes into the adult population. The proposed lake levels in spring should allow access to spawning areas in tributary streams (Barnes Valley and Ben Hall creeks) and provide shallow, flooded habitats that provide cover for larvae and age 0 juvenile suckers. Late summer and winter water depths are anticipated to be minimally adequate to protect water quality.

The primary threat to the SNS population in Gerber Reservoir is an extended drought that would result in very low lake levels that would, in turn, result in large fish kills during the late summer and fall, as well as fish kills in the winter during prolonged ice-cover conditions. The proposed minimum lake elevations are anticipated to provide adequate protection from such conditions in most years. However, lake levels will need to be monitored to ensure that they do not drop below minimum requirements, especially during multi-year droughts. During drought conditions the lake level will continue to decline as a result of evaporation and seepage, even if no water is released. If the lake level at the beginning of a drought is low, lake levels the next year may be even lower, and the lake could go dry in consecutive drought years.

Although we do not anticipate significant sucker mortality events as a result of the proposed action, there will be a significant loss of habitat each year as lake level fluctuates, with resulting adverse effects to suckers due to increased competition for food, higher predation and reduced fitness. Summer lake levels below 4800 ft significantly reduce juvenile and adult sucker habitat in Gerber Reservoir, and likely result in increased competition for food, higher predation and reduced fitness due to parasites and disease (USBR 2002). At a lake elevation of 4815 ft, there are about 2000 acres with adequate depth to support adult suckers. At 4800 ft, the surface area of the lake shrinks to about 750 acres, and thereafter decreases very rapidly, reaching only a few acres and less than 1% of capacity at an elevation of 4796.4 ft. The minimum summer lake elevations proposed by Reclamation (USBR 2002**:** Table 5.6) remain above 4800 ft in most summer months and water-year types, except for July-September of the dry water-year type when lake levels will be lowered to 4799.2 - 4798.1 ft. The Service assumes these minimum elevations would occur no more than twice in 10 years and not in consecutive years. In summer 1992 aeration was necessary to maintain water quality as reservoir levels dropped to a minimum of 4796.4 ft. SNS in the reservoir at that time showed signs of stress including low body weight, poor gonadal development, and reduced juvenile growth rates, but there was no mass mortality.

The effects of fluctuating water elevations at Gerber Reservoir on the resident SNS population in terms of population size, age-class distribution, recruitment, or decreased fitness are not fully understood. However, available information indicates that the Gerber Reservoir sucker population has remained viable under the current management regime (see the discussion of Gerber Reservoir under the “Status of the Species” section).

Sucker access into Barnes Valley and Ben Hall creeks, the principal spawning tributaries for the Gerber SNS population, requires a minimum spring (February through April) elevation at Gerber Reservoir of 4805.0 ft. The minimum proposed elevations for the spawning period will exceed this level in all months and water-year types except in February and March of the dry water-year type when the lake elevation will drop to 4804.2 ft; however, later in April during the dry water-year type, the lake elevation (4808.3 ft) will allow for sucker passage into these spawning tributaries. Thus, the proposed action is anticipated to provide adequate water depths for SNS access to spawning tributaries in all water-year types.

Minimum lake levels are required in high elevation, shallow lakes such as Gerber Reservoir to reduce the threat of low DO levels under an ice cover. In October 1992, the water surface elevation of Gerber Reservoir was at 4796.4 ft before the onset of a hard winter, and no winter fish kills were observed, although suckers showed poor condition factors in the subsequent spring. Accordingly, the Service assumes that 4796.4 ft is the minimum October surface elevation at which the sucker populations can survive through the winter. The minimum proposed elevation for the winter period (October-February) is 4798.0 ft in the dry water-year type. Thus, the proposed action is anticipated to provide adequate water depths for protection against winter-kill of the SNS in all water-year types.

For Miller Creek below Gerber Dam, severe flow reductions at the end of the irrigation season will likely result in stranding of suckers within this reach and could limit reproduction of the suckers residing in the upper Lost River. Miller Creek is likely the only spawning area for suckers in the upper Lost River. The few SNS and LRS forming the sucker populations in the upper Lost River are very small and vulnerable, especially LRS which may number <100 in the entire Lost River, and the added mortality and prevention of reproduction, as a result of low flows in Miller Creek, can only keep this population in a vulnerable state.

5.2.5 <u>Tule Lake</u>

Effects on Habitat Availability and Water Quality

The proposed action continues to provide very limited flows to sustain the few hundred individuals of the LRS and the SNS in Tule Lake. Within Tule Lake**,** suckers encounter adverse water quality and no or very limited suitable adult habitat with water depths > 4 feet deep. Apparently there is no change in operation of Tule Lake since there is no mention of how the sump will be operated in the 2002 BA (see the "Description of the Proposed Action" section of this document), and the Service assumes for purposes of this consultation that it will be operated as it has since 1992.

Under the proposed action, water deliveries to Tule Lake limit the amount of water in the lake with acceptable water quality for suckers and most other fish. During severe winters with thick ice cover, only small, isolated pockets of water with depths greater than 3 ft exist, increasing the risk of winter fish kills. Sediment inputs from upstream actions, such as farming and grazing that are interrelated or interdependent to the proposed action, result in the degraded condition of the Lost River and have eliminated approximately 90 percent of the water depth in emergent wetlands in the Tule Lake sump and if sedimentation continues at the current rate, there may be no useable sucker habitat in a few decades. Proposed flows downstream of Anderson-Rose Dam, the only known spawning location for Tule Lake suckers, apparently have not historically allowed for successful spawning and juvenile cohort development.

The Service views sediment inputs in Tule Lake sump as an indirect effect of the operation of the Project. Although the exact source of the sediment is unknown, it is likely tied to operation of the Lost River as a irrigation channel providing irrigation water to agricultural areas in the Lost River Basin and to drain away irrigation return flows. Fluctuating water levels, as a result of the imbalance of downstream water diversions and upstream discharges from Project reservoirs, leads to bank collapse. Bank instability is made worse by clearing of riparian vegetation. Additional sediment likely comes from return flows and unlined drainage canals.

The long-term survival of suckers in Tule Lake sump is in doubt unless actions are taken to restore natural lows and habitat in the Lost River system. Tule Lake historically supported large and productive sucker populations, based on reported harvests near the beginning of the 20th Century. The Tule Lake population of LRS may be crucial to recovery of that species since it represents one of the three populations. By spreading risk of extirpation among three LRS populations rather than just two populations would significantly decrease the treat of extinction risk to this species. Loss of the Tule Lake population may prevent recovery of the LRS, thus putting its long-term viability at risk.

5.2.6 <u>Summary of Water Management Effects</u>

Water management by the Project may have substantial adverse effects on the conservation needs of the SNS and LRS by: 1) contributing to poor water quality increasing the numbers of suckers that die from fish kills; 2) reducing habitat for all life stages; 3) reducing recruitment through adverse effects on sucker habitat quantity and quality; and 4) contributing to conditions that increase competition and/or predation by exotic fishes.

5.3 Effects of Dams

The proposed operation of dams under the Project will affect the following conservation needs of the suckers:

- The need to provide access to adequate habitat for all lifestages; and
- The need to provide passage and connectivity between populations.

The proposed action will continue operation of the six primary Project dams, none of which currently provides suitable passage for suckers. The dams: physically isolate sucker populations; prevent genetic exchange between populations; block access to essential spawning, larval, and rearing habitat; cut off escape from adverse conditions downstream; and prevent the return of entrained suckers to upstream habitat and spawning areas. The proposed fish ladder at the Link River Dam should allow spawning adults to pass the dam, but the smaller juvenile and sub-adults will remain isolated downstream where their survival will be reduced by poor water quality conditions. The inadequacies of the present passage facilities exacerbate the adverse effects of entrainment because the sucker populations can not compensate for entrainment effects through reproduction due, in part, to passage barriers.

At present, none of the six primary Project dams operated by Reclamation, or those operated by PacifiCorp downstream, are fitted with passage devices adequate to pass suckers effectively. None of the Project dams are designed such that suckers that pass downstream over the dams, or are entrained in the irrigation system, are able to return upstream to spawning and rearing areas. The fish, therefore, lose access to essential adult habitat (e.g., UKL), and have no way to escape adverse conditions downstream (e.g., dewatering). Sucker populations upstream and downstream of the dams are physically isolated and, therefore, genetic exchange between populations is severely restricted (one way exchange). Hybridization between sucker species trapped below dams may also occur at higher frequencies because spawning fish are restricted to small and inadequate spawning areas. Only three facilities (the Link River, Keno, and J.C. Boyle dams) have some form of fish ladder. However, all of these ladders have design limitations, were intended only for salmonids, and are of very limited utility for suckers. The Clear Lake, Gerber, Malone, Wilson, and Anderson-Rose dams have no fish passage facilities, nor are any planned as part of the proposed action.

Prior to construction of the Link River Dam, there were apparently large spawning runs of suckers migrating up the Link River in the spring; these runs were described as “immense congregations” of fish weighing two to six pounds (Klamath Republican 1901). Millions of sucker larvae and tens to hundreds of thousands of juveniles are currently entrained at the head of Link River through the A-Canal, and past the Link River Dam. Screening of the diversions will result in a greater number of young suckers moving downstream into the Keno Impoundment and Klamath River reservoirs. The presence of low numbers of adult suckers attempting to use the Link River and Keno fish ladders, even given the limitations of the facilities, demonstrates that some suckers are surviving downstream and are still attempting to return to UKL. This potentially vital component of the UKL sucker populations currently have little, if any, opportunity to return to the lake when they approach maturity and are ready to enter the breeding population.

5.3.1 Summary of Dam Effects

Operation of Project dams may have substantial adverse effects on the conservation needs of the SNS and LRS by: 1) blocking access to essential spawning, larval, and rearing habitat; 2) cutting-off escape from adverse water quality conditions downstream; and 3) blocking connectivity between population thus preventing genetic exchange.

5.4 Effects of Entrainment

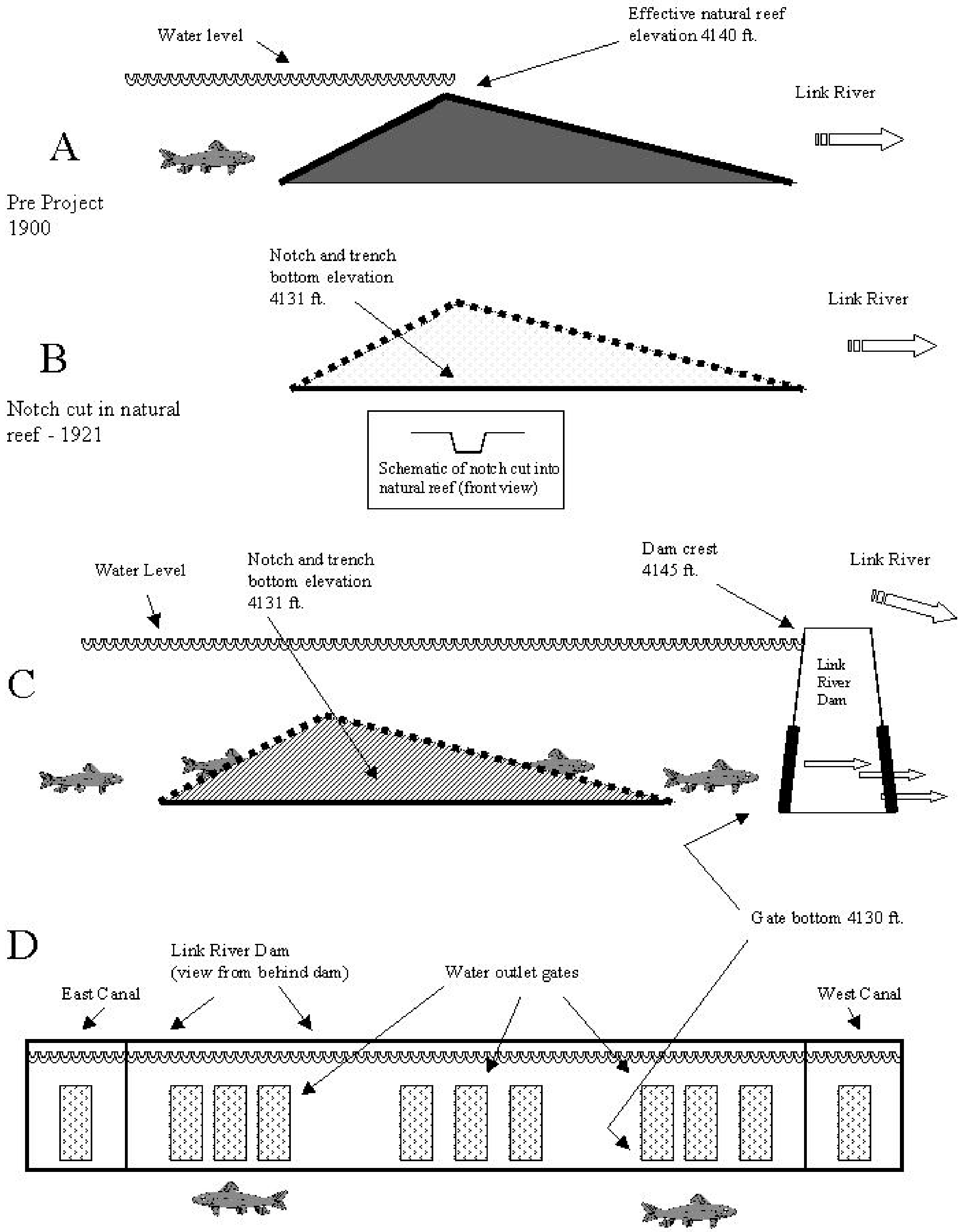
The operation of irrigation diversions and dams within the proposed project will adversely affect the following conservation needs of the suckers:

- The need to increase population size;
- The need to ensure recruitment;
- The need to prevent entrainment mortality; and

Based on studies done since 1992, the proposed action is likely to result in the annual entrainment of millions of larvae, tens of thousands of juveniles, and hundreds, if not thousands, of adult suckers (Gutermuth et al. 1997, 1998b, 1999, 2000a, 2000; Harris and Markle 1991; Markle and Simon 1993; Simon and Markle 2001; USBR 2002b). Extensive entrainment of suckers occurs in many diversions throughout the Project area. Entrainment of suckers and other fish at these diversions has been shown to be a substantial source of mortality for both larval, juvenile and adult suckers, as described below. Furthermore, entrained suckers, even if they survive, are lost to the spawning populations due to adverse downstream habitat conditions and upstream passage barriers preventing their return. There are no fish screens at Project diversion sites that meet State or Federal screening criteria. Reclamation is currently in the final design phase for construction of a fish screen at the A-Canal, which should be operational by July 22, 2003. However, the proposed facility will not screen larval fish under about 30 mm, and so larval entrainment of suckers can be expected to continue at the levels reported below. Suckers screened from entering A-Canal will still be subject to entrainment just downstream at the Link River Dam.

Significant entrainment of suckers from UKL occurs at the A-Canal and Link River Dam (see discussion below under “Entrainment of Larval Suckers” and “Entrainment of Juveniles and Adults”). The configuration of Link River Dam and the hydropower diversion canals, combined with the alteration and channelization of the hydrographic outlet to UKL, results in water being withdrawn from deeper depths than would have occurred prior to these changes (Figure 5.4-1). Withdrawal of water from near the bottom of the channel puts bottom-oriented fish, like juvenile and adult suckers, at significantly higher risk of entrainment.

Figure 5.4-1. Schematic of pre-Project natural outlet to Upper Klamath Lake, alterations made by notching and channelization of the natural outlet sill, and construction of dams and diversions (This is only a representative diagram and is not to scale.)



The Link River Dam controls the release of water out of UKL and results in the entrainment of suckers to the Link River below the dam. Water release is either through the dam, by way of gates, or through the two hydropower canals, located on each side of the dam. Entrainment past the dam results in isolation of fish downstream of UKL in the Link River or Keno Impoundment. At this time, the Keno Impoundment does not provide suitable long-term habitat for suckers, due to frequently lethal water quality conditions. Also, upstream passage is not possible at Link River Dam for juveniles or subadults, nor is it proposed. Entrainment into the two hydropower diversions further threatens fish due to injury and mortality in the turbines, which has been estimated at 10-26% direct mortality, with unquantified losses due to injury (USBR 2002b).

Entrainment also occurs at other diversions in the Project. At Clear Lake Reservoir, a large barrier net has been placed in the forebay since 1993 during the irrigation season to reduce entrainment. A 1-inch square mesh net was used from 1993 to 1998; a ¾-inch square mesh net was used in 1999-2000; and a 1.3 cm stretch mesh was used in 2001. Based on end-of-season fish salvage from the dam outlet, the net placement appears to have been fairly effective in reducing loss of juvenile and adult suckers (USBR 2000b, 2002a). However, following increased releases from Clear Lake in September 2000, many more suckers were salvaged below the dam even though new nets were in place in the dam forebay area. Reclamation has proposed to screen the outlet at Clear Lake Dam as part of the dam reconstruction to be completed by May 1, 2002.

Numerous additional point diversions exist in the Project area, including: J-Canal, Q-Canal, Pumping Plant D, and the Lost River Diversion Canal (USBR 1992a). Reclamation inventoried most non-Project pump diversions in the Lost River in 1998 (USBR 2000b). Diversions used either gravity or electrically powered pumping stations (USBR 1992a). Reclamation, through its contractors (irrigation districts), has implemented measures to reduce sucker stranding in canals at the end of the irrigation season and has conducted, and proposes to continue, annual salvage operations in Project canals to reduce stranding and killing of suckers (see "Entrainment of Juvenile and Adults" below). The proposed action does not pose any additional impacts related to gravity and pumped diversions than considered in previous consultations.

Under the proposed action, water will be diverted from the Tule Lake sump for irrigation and also moved from Tule Lake to Lower Klamath Lake via Pumping Plant D and the Tule Lake Tunnel. These diversions are likely to have an adverse impact on suckers (especially on larval suckers, if present) through direct mortality if they are entrained through the pumps, or mortality through desiccation, aquatic vegetation control, predation, and poor water quality associated with the canal systems. Suckers that do survive these diversions will still be lost from the Tule Lake population and may be trapped in canals where they cannot complete their life cycle, where water quality is adverse, or where water is removed at the end of the irrigation season.

5.4.1 <u>Entrainment of Larval Suckers</u>

Larval sucker entrainment into Project diversions has been extensively studied (Harris and Markle 1991; Markle and Simon 1993; Gutermuth et al. 1997, 1998b, 1999). The seasonal timing of larval drift into the A-Canal and past the Link River Dam is similar, starting as early as late April and continuing into late July, with peak entrainment during June. The highest density of drifting sucker larvae occurs primarily at night and near the surface, which is similar to larval outmigration in the Williamson River (Buettner and Scoppettone 1990; Gutermuth et al. 1998b; Harris and Markle 1991; Klamath Tribes 1996).

Larval entrainment was found to be high in all studies. The lowest estimate was in the 1990 A-Canal entrainment study, when approximately 400,000 larvae were entrained into just the A-Canal (Harris and Markle 1991). Entrainment was likely greatly underestimated in this study, because sampling began too late in the season, after much of the entrainment was suspected to occur, and there was no nighttime sampling. In a 1991 study, under similar constraints, it was estimated that 800,000 sucker larvae were entrained into the A-Canal (Markle and Simon 1993). The more complete 1996 and 1997 entrainment estimates (full season and 24-hr sampling) for larval and early juvenile suckers (<74 mm in length) were 3,000,000 in 1996 and 1,700,000 in 1997 (Gutermuth et al. 1998b).

Management of UKL elevations probably contributes to some increase in larval entrainment relative to the hydrologic baseline conditions. During all water-year types, additional water is withdrawn from the lake each summer by the Project because lake levels are higher under the proposed action in spring and they are lower than the baseline by the end of the irrigation season (Figure 5.2.1-1). The greatest withdrawal of water occurs in the May to July period when larvae are present in the lake. Any larvae that are not in emergent marshes would be swept by currents to the south end of the lake where they are entrained in A-Canal or past the Link River Dam.

5.4.2 Entrainment of Juvenile and Adult Suckers

Studies designed specifically to quantify juvenile and adult sucker entrainment into the A-Canal were conducted in 1997-1998 and for Link River Diversions (East and West Canals) in 1997-1999 (Gutermuth et al. 2000a, b). Juveniles (age 0) make up the majority of the entrained suckers (85-99 %) and most are caught in late July-September. Adult suckers (over 25 cm FL) are generally caught from July through October. A peak of entrainment rates for larger suckers (>15 cm FL) in August-September of 1997 was associated with a drop in DO levels and was considered primarily the result of stressed and debilitated fish moving from severely degraded water quality conditions in UKL during a fish kill. Entrainment estimates from the Link River hydropower diversion studies are considered to represent potential entrainment past the Link River Dam, were that water to go directly through the dam, since diversion structures for the dam gates and hydropower diversions are similar. No information is available for direct entrainment through the dam gates.

The total entrainment estimates for A-Canal and the two Link River hydropower diversions represent a large percentage of the total population estimates of juvenile suckers in UKL (Table 5.4.2-1). Increases in entrainment are associated with apparent declines in the lake populations of suckers (Simon and Markle 2001). In both 1997-1998, catches of juvenile sucker in UKL declined precipitously to below the entrainment values in September and October. Differences in gear and uncertainties of sampling efficiencies make it impossible to directly quantify the exact percent of young suckers produced in UKL that are ultimately entrained by the diversions. However, it is clear that entrainment itself accounts for a substantial component of the age 0 juvenile mortality.

Table 5.4.2-1. Entrainment of juvenile suckers at the A-Canal and Link River Diversions compared to the total UKL, age 0, juvenile population estimate in August (derived from Gutermuth et al. 2000a, 2000b; Simon and Markle 2001).

	YEAR	
	1997	**1998**
Upper Klamath Lake		
UKL Juvenile Population Estimate - August	82,477	665,421
- September	2,657	33,818
Entrainment into Diversions		
A-Canal Entrainment	44,974	245,642
Link River Diversions	19,394	82,817
Total Entrainment	64,368	328,459
Total Entrainment as a Percent of the UKL August Juvenile Population Estimate	78 %	49 %

Reclamation has conducted salvage operations from Project canals receiving water from UKL annually since 1991 (USBR 1996a, 2000b, 2002a). Salvage has been considered a stop-gap measure to reduce losses from and obtain information on the magnitude of entrainment. Between 1996 and 1999, the numbers of suckers salvaged increased annually from 11,000-27,000. Sucker salvage in 2001, a year of reduced diversion flows in the A-Canal and reduced salvage effort, captured 587 suckers, with nearly all caught in the two stations nearest the headworks. Age 0 fish dominated the 1996, 1998 and 1999 salvage operations, while age 1+ were more abundant in 1997 and 2001. The canal salvage data should be viewed as a qualitative index, since there are several factors that influence the numbers salvaged. Poor water quality conditions have been documented in several years that likely resulted in high mortality of canal fish (Gutermuth et al. 1998b). Varying levels of success in draining the canals and guiding suckers out of the canals into the Lost and Klamath rivers may also affect the results. Additionally, only a small percentage of the canal system is sampled and electrofishing is very inefficient in the canals, so large numbers of suckers are undoubtedly missed.

5.4.3 Summary of Entrainment Effects

Operation of Project diversions may have substantial adverse effects on the conservation needs of the SNS and LRS by: 1) preventing an increase in LRS and SNS population size by entraining suckers from each population; 2) reducing recruitment by entraining large numbers of larvae and juveniles; and 3) causing entrainment mortality of all life-stages.

5.5 Effects of Pesticides Used on Klamath Project Lands

The application of pesticides within the Project area may affect the following conservation needs of the suckers:

- The need to increase population size;
- The need to reduce the effects of poor water quality; and
- The need to provide adequate habitat for all life-stages.

The proposed action includes application of pesticides in the vicinity of sucker-occupied waterways. Pesticides and other agrochemicals are used on Project right-of-ways, in Project canals, and on private lands that receive Project water. Agricultural activities on these private properties are considered in this opinion to be interdependent or interrelated to the operation of the Project, as discussed in the "Description of the Proposed Action," section, if the activities are dependent on Project water or if Project drains are used.

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) requires that risk of pesticides to wildlife be assessed during the pesticide registration process which is administered by the U.S. Environmental Protection Agency (EPA). Under the Endangered Species Act, EPA must ensure that use of pesticides it registers will not result in take of listed species. EPA uses the risk quotient method to assess risk of pesticides to fish and wildlife. Risk to listed species is identified when endangered species Level of Concern (LOC) criteria are exceeded (EPA 1986). In some causes, pesticide labels are modified to address the LOC. In causes where endangered species concerns are not addressed with label modifications the EPA must consult with the Service on particular species and implement use limitations that are either specified in biological opinions or developed from those opinions. EPA has not consulted with the Service on LRS or SNS and has not instituted any specific use limitations to protect these species or their critical habitat.

In 1988 the EPA started an Endangered Species Protection Program to address endangered species concerns. The idea was to develop county bulletins that contain maps of species locations and pesticide use limitations. However, EPA has not fully implemented this program. There are no bulletins for Klamath County, Oregon. California has developed bulletins for Siskiyou and Modoc counties, but pesticide applicators are not legally bound to follow the application recommendations specified in bulletins. Compliance with county bulletin restrictions is strictly voluntary. Modoc and Siskiyou county bulletin indicates that pesticide products containing one or more of 100 different active ingredients warrant use limitations above current label restrictions to protect SNS and LRS.

The Service's February 9, 1995, BO (FWS log # 1-7-95-F-26) provided incidental take coverage for use of the aquatic herbicide acrolein in Project irrigation canals operated by the Klamath Irrigation District and the Tulelake Irrigation District. The 1995 BO was amended on August 18, 1999 (FWS log # 1-10-99-F-103), to include canals operated by Langell Valley Irrigation District

(LVID), when it was realized that LVID was not covered by the 1995 BO. Mosquito control in Project canals by the Klamath County Vector Control was also considered in the February 9, 1995, BO. The effects of pesticide and fertilizer use on the Federal lease lands near the Tule Lake NWR, is also covered by the February 9, 1995, BO and amendments. Because pesticide use on Project rights-of-ways and canals have been consulted on, impacts to listed suckers should be minimized. However, we have insufficient information on pesticide use on private lands that use Project water or canals. Therefore, any adverse effects to suckers as a result of pesticide use on these lands will not be addressed in this BO. Until Reclamation provides information to the contrary, we consider pesticide use on private lands to be a potential threat to both species. This threat to suckers is minimized when pesticides are used according to label instructions and county bulletins and adequate buffer strips are used adjacent to open water or canals.

Pesticides are known to have a wide variety of adverse effects on aquatic species including direct effects such as mortality from acute exposure or reproductive impairment from chronic exposure. Pesticides can also impact fish indirectly by modifying their habitat.

<u>Summary of Pesticide Effects</u>

Use of pesticides, as an interrelated action to the operation of the Project, may have adverse effects on the conservation needs of the SNS and LRS by: 1) decreasing population size by reducing fitness; 2) contributing to poor water quality; and 3) adversely affecting habitat for all life-stages

6.0 CUMULATIVE EFFECTS ON THE SHORTNOSE AND LOST RIVER SUCKERS

Cumulative effects are those effects of future non-Federal (State, local governments, or private) activities on endangered and threatened species or critical habitat that are reasonably certain to occur within the action area of the Federal activity subject to consultation. Future Federal actions are subject to the consultation requirements established in section 7 and, therefore are not considered cumulative to the proposed action.

6.1 Upper Klamath Lake Sub-Basin

Private water diversions and pumping of groundwater in the UKL watershed affect suckers by reducing UKL inflows, thus reducing lake levels and water quality, and perhaps entraining suckers and other fish. Reduced flows from the upper Williamson River affect input of humic substances (by-products of decayed plant material that originate from Klamath Marsh and other wetlands associated with the river) into UKL. Humic substances are believed to inhibit *AFA* growth (Geiger 2001). Reduced flows from the Wood River and west-side streams such as Sevenmile Creek, as a result of diversions, also likely to reduce humic input into UKL.

Private landowners along tributary streams to UKL annually exercise their State of Oregon rights to withdraw water for irrigation and livestock watering. The total amount of water that is annually withdrawn before it reaches UKL has not been determined but is substantial. It is estimated that about 186,000 acres benefit from diversions. Total off-stream diversion equals about 400 thousand acre feet (TAF) from UKL tributaries (Sprague River = 87 TAF, Williamson

85 TAF, and Wood River 224 TAF [Broad and Collins 1996]). Permitted water withdraws from the UKL sub-basin have more than doubled in the past 40 years (Risley and Leanen 1999). Nutrient-enriched return flows from these upstream agricultural lands, coupled with the reduced inflows to the lake (about 170 TAF), because of irrigation depletion, likely contribute to the eutrophication in UKL. The resulting lowered water level and poor water quality may affect all three listed species considered in this BO.

Despite high background phosphorus levels in UKL tributaries and springs (Kann and Walker 1999; Rykbost 1999, 2001), data exists from several studies to indicate that phosphorus loading and concentrations are elevated substantially above these background levels (Miller and Tash 1967; USACE 1982; USBR 1993a, 1993b; USGS Water Resources Data 1992-1997; Kann and Walker 1999; Eilers et al. 2001, ODEQ 2001).

Studies show that drained and diked wetlands consistently pump effluent containing 2-10 times the phosphorus concentration of tributary inflows (USBR 1993a, b), and that nitrogen and phosphorus are liberated from drained wetland areas, leach into adjacent ditches, and are subsequently pumped to the lake or its tributaries (Snyder and Morace 1997). Coupled with the considerable but diffuse non-point contribution stemming from wetland loss, flood plain grazing, flood irrigation, and channel degradation, the total phosphorus input from anthropogenic sources likely accounts for a far greater percentage than that indicated by the 30% contributed due to direct pumping alone. Gearheart et al. (1995) estimated that over 50% of the annual total phosphorus load from the watershed could be reduced with management practices, and Anderson (1998) likewise estimated that in-lake total phosphorus concentration could be reduced by using watershed management strategies. Walker (1995) also estimates that an increase in Agency Lake inflow concentration of phosphorus from approximately 80 to 140 ug/l (40%) is due to anthropogenic (human induced) impacts.

The Williamson River and Wood River together accounted for 67% (48% and 19%, respectively) of the 1992-1998 total phosphorus load, with springs and ungauged tributaries contributing another 10%. Precipitation, Sevenmile Canal and agricultural pumping accounted for the remaining 23% (Kann and Walker 1999). Unlike the water contribution, where Wood River, Sevenmile Canal, and Pumps contribute 25% of the water load, these same sources contributed 39% of the average annual total phosphorus load. In contrast, springs contributed 16% of the water input, but contributed only 10% of the total phosphorus load. This appears to be partially due to the consistently higher volume weighted total phosphorus concentration occurring in the pump effluent, and Wood River and Sevenmile canal systems.

Because the Sprague River watershed is impacted by wetland and riparian loss, flood plain grazing, agricultural practices, and channel degradation, it is prone to total phosphorus export, especially during major runoff events.

Eiliers et al. (2000) using paleolimnology techniques examined nutrient content of UKL sediments over the past 1000 years. Based on a variety of analyses they determined that sediment accumulation rates and levels of phosphorus in sediment have increased significantly in the past 150 years. They attributed these increases to anthropogenic, watershed effects, such as forestry, agriculture, and grazing. Their results were consistent with those of Coleman and Bradbury who found increased amounts of tephra (volcanic ash) in recent UKL deposits, suggesting increased upland erosion rates (USGS unpub. data).

6.1.1 Agency Lake and Wood River Watershed

Numerous farms and ranches in the Fort Klamath area divert significant quantities of water out of the various streams and springs in the watershed upstream and adjacent to Agency Lake north of UKL. The natural streams in this area include: Sevenmile Creek, Fourmile Creek, Annie Creek, the Wood River, and Crooked Creek. Additionally, water from various natural springs is diverted to various maintained ditches which supply irrigators in the area. Major ditches conveying water from the natural creeks and springs to the irrigators include: Bluespring, Threemile, Fourmile, Sevenmile, and Melhase Ditches. Return flows from these ditches are collected into several canals which connect with and are adjacent to Agency Lake. These canals contain water year round and include: West, Sevenmile, Central, and North canals among others. The Meadows Drainage District and many individual landowners divert water through the aforementioned ditches. A more detailed description of these diversions is given in Reclamation's 1992 BA (USBR 1992a).

Juvenile LRSs and SNSs are known to occur in the Wood River and Crooked Creek (D. Markle, OSU, pers. comm.). It is suspected that some sucker spawning does occur in these tributaries to Agency Lake. Depending on how far these spawning fish migrate upstream in the Wood River and Crooked Creek, the adult spawners, embryos, and emerging larvae of these suckers may be impacted by water diversions from these tributaries. If spawning suckers are in downstream reaches of the Wood River and Crooked Creek below the irrigation diversions when water deliveries to the ditch systems are diverted out of the channel, then the spawning behavior of these fish may be disrupted, resulting in no sucker spawning in that year.

In 1991, Markle (1992) found that larval suckers were emigrating through the lower Wood River into the confluence with Agency Lake in late July. This corresponds to the approximate peak of water diversion (June-mid August) from the Wood River and Crooked Creek. Therefore, if suckers succeed in spawning within the reaches downstream of the ditch diversions, the embryonic and emergent life-stages would potentially be subject to diversions into canals and fields, reduced flows, and resulting elevated water temperatures during incubation and larval emigration. Suckers are also entrained by diversions and likely die as a result of poor water quality or being entrained into pumps.

Depending on land practices, use of agrochemicals, the number of reuses, and erosion in the agricultural area, the water quality (including DO, turbidity, ammonia, and temperature) of these return flows could range from fair to extremely poor. The return water, upon collection in the downstream canals, could then potentially impact the water quality of marsh and near-shore habitats of larval, juvenile, and or adult suckers or other fishes present.

Nutrient-rich irrigation return water reaching Agency Lake could result in *AFA* blooms and anoxic conditions within Agency Lake itself. These noxious blooms and resulting degraded water quality could potentially result in fish kills in Agency Lake during the late summer months.

6.1.2 Williamson River Watershed

In the upper Williamson River watershed, grazing and forestry has adversely affected stream morphology, with the result that the river is entrenched. Agricultural practices in the drainage could have the same effects as those listed above for the Agency Lake drainage. Unscreened irrigation diversions on the lower Williamson River in the area of concentrated larval migration and rearing may be reducing sucker recruitment to UKL. Irrigation diversions also reduce stream flows.

6.1.3 Sprague River Watershed

Chiloquin Dam

Chiloquin Dam, located just upstream of the Sprague River's confluence with the Williamson River, is estimated to have eliminated more than 95% of the potential spawning habitat for the LRS and SNS and is considered one of the more significant reasons for the decline of the suckers (Service 1987, 1988). Although the dam has a fish ladder, the dam has previously been considered as an almost total barrier to the annual spawning migrations for the endangered suckers (Stern 1990); however, more recent data shows that a substantial number of suckers may use the ladder, although information pertaining to passage success is not currently available (R. Shively, pers. comm. 2001).

Partial blockage of the suckers at the Chiloquin Dam during their upstream spawning migration may force suckers to spawn in the short river reach immediately downstream of the dam. Spawning of multiple related species within a relatively confined area may cause hybridization, although this has not been confirmed. The LRS and SNS have been observed spawning together below Chiloquin Dam (L. Dunsmoor, pers. comm.). Sucker spawning and rearing habitat in reaches downstream of the dam are very likely limited. In addition, mass spawning of the suckers in confined areas close to UKL may create adverse density-dependent conditions limiting recruitment of larval suckers (e.g., competition for limited food supply and rearing habitat in confined areas of the lower Williamson River). If existing limited fish passage conditions at Chiloquin Dam persist, it will very likely incrementally restrict recovery efforts for the endangered suckers.

Agriculture

Sucker spawning habitat in the Sprague River has been degraded by channelization (e.g., about 4 mi of the Sprague are channelized upstream of Ivory Pine Road), sedimentation, increased water temperatures, high nutrient concentrations, and the resulting growth of periphytic algae and aquatic macrophytes (ODEQ 2001). These problems originate in the Sprague River Valley, upstream of the present-day spawning areas, where agricultural activities have degraded the riparian habitat. In addition to the resulting loss of spawning habitat, the Sprague River is a major contributor of excess nutrients to the hypereutrophic UKL. Long-term success of spawning habitat restoration efforts in this river system depend almost entirely on rehabilitation of the upstream reach of the Sprague River (Service 1992).

6.1.4 <u>Out-of-Basin Transfers in the UKL Sub-basin</u>

Although there may be others, the Cascade Canal is the only large out-of-basin transfer affecting the UKL sub-basin. The Cascade Canal diverts water from Fourmile Lake into the Rogue River basin. The dam at the outlet of Fourmile Lake was built in 1922. About 6,100 ac-ft (range = 1,200 - 11,500 ac-ft) are diverted annually from Fourmile Lake via Cascade Canal to Fish Lake, where the water is used by Reclamation's Rogue River Basin Project (Tarbet 2001). Annual flows to the headwaters of Fourmile Creek are estimated to be reduced by 6,100 ac-ft, from 8,000 to 1,900 ac-ft, mostly from April to July. Without regulation, the average flow of Fourmile Creek into UKL would be <10,000 ac-ft.

The effect of diversion of flows from Fourmile Creek on the endangered suckers is unclear. Assuming that about 5 TAF are actually lost to UKL as a result of the out-of-basin diversion, this is an insignificant amount compared to the estimated >1 million acre-ft inflow. However, a more accurate comparison would be made by comparing the loss to the flows and discharges of the springs and minor creeks flowing into UKL which is about 26 TAF. In this comparison the 5 TAF-loss would represent about 20% of inflow. Further, this loss could be significant to suckers since it would be occurring in the Pelican Bay area, a known water quality refuge area for suckers. However, since most of the flow is in May and June, it would have little effect on the water quality refuge areas that are important to suckers in July - September. Suckers once used Fourmile Creek for spawning but no longer do so. It is unknown if this is related to flow reduction in Fourmile Creek.

6.2 Lost River Sub-Basin

6.2.1 <u>Clear Lake Watershed</u>

Most of the land in the Clear Lake watershed is Federally-owned; Federal actions affecting listed species will undergo section 7 consultation and are not considered further in this section. Remaining land is in private ownership and is mostly open juniper-bunchgrass rangeland with small numbers of ponderosa pine. Few people live in the area. The Service anticipates that most of this land will be used as it has in the past as range- and forest-land.

Grazing

Grazing, as currently practiced in the Clear Lake watershed, is not considered by the Service to be a significant threat to suckers. Limited areas of private rangeland are located in the Clear Lake watershed, often in key riparian and wetland areas. The adverse effects of grazing on water quality was discussed previously. Grazing in the Clear Lake watershed has previously destabilized streambank vegetation, resulting in erosion, siltation, reduced quantities and quality of gravel spawning areas, increased water temperatures, and caused wider and shallower stream channels, and lowered water tables (Modoc National Forest 1991). The condition of rangelands in this watershed is anticipated to continue to improve with proactive management.

Forestry

Forestry practices may also contribute to water quality declines in the upper Lost River Basin. However, because commercial forest comprises such a small area and will be infrequently harvested, the Service does not consider forestry in the Clear Lake watershed to be a significant threat to LRS and SNS.

Introduced Fishes

Fishes such as the brown bullhead, fathead minnow, Sacramento perch, yellow perch, pumpkinseed, green sunfish, bluegill, crappie, largemouth bass, and brown trout have been accidentally or intentionally introduced in the Lost River Basin. Because relatively stable sucker populations coexist with abundant non-native fish populations in Clear Lake, the Service does not consider exotic fish to be a current threat there.

6.2.2 Gerber Reservoir Watershed

Private Water Developments

There are six private water developments in the Gerber Reservoir watershed (USBR 1970c). These developments are primarily for livestock operations. Approximately 13,300 acres of both privately held and Forest Service permitted land are included in these developments. Each of these operations uses a combination of dams, reservoirs, and ditches to distribute water or use dikes, ditches and canals to irrigate their lands. Use of these water rights are primarily for pasture and hay, and grain cultivation.

The effects of these impoundments on the LRS and SNS populations in Gerber Reservoir watershed are unknown. During periods of above-average precipitation SNSs are known to occupy some of these impoundments. Water storage may increase instream flows during the summer. The impoundments also may trap sediments keeping them out of downstream pools and runs where SNSs reside or spawn. However, water stored in these reservoirs from spring flows may decrease instream flows necessary for SNS spawning migrations, such as in Ben Hall Creek (A. Hamilton, BLM, pers. comm.).

Other Effects

Land use in the Gerber Reservoir watershed is similar to that of Clear Lake, perhaps with more commercial timber on private lands. Forestry and grazing that follow established best management practices are not considered to be a significant threat to SNS in the Gerber Reservoir watershed.

6.2.3 Lost River and Tule Lake Sumps

The Tule Lake Sumps are on federal land but are affected by adjacent land uses and upstream water quality in the Lost River. The Service anticipates that private lands in the Lost River Watershed will contribute nutrients, sediment, and pesticides to the Tule Lake sumps which will affect listed suckers. These contributions may be adverse to sucker habitat and water quality. The Service does not currently have information on the magnitude of this potential impact.

6.3 Klamath River Sub-Basin (Lake Ewauna to Iron Gate Dam)

6.3.1 Agricultural Diversions

Agricultural (irrigation) diversions from the main stem of the Klamath River upstream of Copco Reservoir #1 and the California-Oregon border provide water to private landowners through a lease of water rights (Beak Consultants 1987). While these structures are relatively large, they probably do not impede fish passage in this river reach (Shrier, PacifiCorp, pers. comm.). More detailed information about these diversions are given in Reclamation's BA (USBR 1992a). Most of these diversions are unscreened. The timing, volume, and the pattern of use of these irrigation diversions as well as their impact (if any) on sucker populations are unknown, although impacts due to water quality and entrainment are likely.

6.3.2 Other Sources of Potential Impacts

Water quality on the main stem of the Klamath River upstream of the Keno Regulation Dam can at times be degraded due to treated sewage, storm water and non-point source runoff from the City of Klamath Falls. Lumber mills along the Klamath River near Klamath Falls also contribute to water quality problems in the river. The impoundment of the nutrient rich waters in the reservoirs are known to contribute to *AFA* blooms within the reservoirs and cause downstream *AFA* nuisance conditions in the river (Klamath River Basin Fisheries Task Force 1991). The nutrient loads in these reservoirs and the river are known to be elevated, with 79 percent of the nitrogen and 68 percent of the phosphorus in the Klamath River coming from sources upstream of Iron Gate Dam (CDWR 1986, as cited by The Klamath River Basin Fisheries Task Force 1991).

6.4 Other Cumulative Effects

The transportation of hazardous materials by truck and train along the eastern, southern, and southwestern shore of UKL and over tributaries could result in spills and negative impacts to the listed and unlisted species in the basin's waters. The greatest hazardous spill risk to the suckers comes from the rail line that skirts the eastern shore of UKL for about 10 miles. Considerable quantities of hazardous materials are carried over this line on a daily basis. Oregon Department of Transportation (ODOT) records indicate that over 10,000 total car loads or intermodal loads of hazardous material were transported on the rail line between Klamath Falls and Crescent Lake, Oregon during 2000 (ODOT 2002). Materials transported included several categories of toxic substances including solvents, strong acids, petroleum products, fertilizers, chlorinated compounds, and other environmentally hazardous substances that could adversely affect listed species.

Although we have no record of train derailments that have resulted in the deposition of hazardous materials into UKL, both derailments and releases of hazardous material have occurred in this area. During the 1980's there were two hazardous materials incidents near

Modoc Point. One involved the derailment of 6 tank cars carrying propane (Union Pacific 2001). The other resulted in the release of titanium tetrachloride vapors. During the summer of 2001, several hundred railroad ties and other treated wood debris were removed from Hank's Marsh. Evidence suggested the ties were deposited in the lake or along its shores during several separate train derailments decades earlier (J. Mueller, pers. comm. 2002). Although the probability of a spill may be relatively low today, the risk posed to suckers and other aquatic species in the event of a spill is high.

The ODEQ has indicated a desire to develop a Geographic Response Plan (GRP) for UKL. Initial response activities are critical to minimizing the impacts of a spill (C. Donaldson, ODEQ, pers. comm. 2001). In the case of a large spill of hazardous material at UKL, EPA would serve as the federal on-scene coordinator. ODEQ would serve as the state on-scene coordinator. It would likely take several hours to organize the incident command and get them on site. Several additional hours would be needed to develop an Incident Action Plan in absence of an existing GRP. The USFWS would provide technical assistance and possibly be integrated into the Environmental Planning Unit where endangered species are at risk. The time spent organizing the initial response could play a major role in affects to listed species and other natural resources in the UKL area. A GRP would prioritize first-response protection measures in the event of a hazardous materials spill and would presumably provide for a more effective response. However, funds have not been allocated for the development of the UKL GRP. There are no site-specific protection measures currently in place to minimize the impacts of hazardous materials spills to suckers and other species that use UKL.

AFA and *Daphnia* harvesting in UKL may result in the take of larval and juvenile suckers. The use of chemicals such as pesticides, herbicides, and mosquito or "midge" control chemicals could result in negative impacts to listed species throughout the basin. The diversion of water directly from UKL by private (non-Project) water users could result in the entrainment, injury, and death of suckers and reduction of habitat.

6.4.1 Restoration Activities

Restoration of aquatic habitats and uplands to improve watershed function will be essential for reducing threats and meeting the conservation needs of the suckers. Such activities also will increase stream flows, raise the water table in pastures, increase wildlife habitat, and have other general benefits. A discussion of current and future benefits of restoration activities as they relate to the conservation needs of the suckers is found in the "Environmental Baseline" section of this document.

7.0 CONCLUSION

After reviewing the current status of the LRS and the SNS, the environmental baseline for the action area, effects of the proposed action, and cumulative effects, it is the Service's biological

opinion that implementation of Reclamation's 10-year operation plan for the Klamath Project, as proposed, is likely to jeopardize[1] the continued existence of the LRS and the SNS.
We reached this conclusion based on the following anticipated effects of the proposed action on the reproduction and numbers of the LRS and the SNS at UKL that are incompatible with the conservation (i.e., survival and recovery) needs of these species.

7.1 Sucker Entrainment at Project Dams and Diversions in Upper Klamath Lake

Project water diversions, including dams and hydropower diversions, in UKL will entrain millions of larvae, tens of thousands of juveniles and possibly thousands of sub-adult and adult suckers. This entrainment substantially reduces sucker populations and limits the amount of recruitment into the adult spawning populations. The screening of A-Canal by 2003 will reduce entrainment losses of juvenile, sub-adult, and adult suckers. However, entrainment of larvae will be only minimally reduced. Entrainment of all sucker life stages will continue to occur under the proposed action at the Link River Dam. The number of suckers entrained at the Link River Dam and diversions are likely to increase if suckers bypassed from the A-Canal move a short distance downstream to the Link River Dam. Suckers entrained past the dam will be trapped downstream in the Link River, Lake Ewauna and the Keno Impoundment. The proposed fish ladder at the Link River Dam should allow spawning adult suckers to return upstream past the dam, but the smaller juvenile and sub-adults will remain isolated downstream where their survival will be reduced by poor water quality.

Sucker entrainment of this magnitude will appreciably reduce recruitment of new age classes into the adult spawning population and increase the risk that future fish kills will further depress sucker populations.

7.2 Effects of Project Operations on Water Quality in Upper Klamath Lake

Proposed water management under the Project is likely to have substantial adverse effects on water quality and sucker health in UKL under certain conditions. Shallow water depths during dry and critically dry inflow year types are likely to increase the frequency and magnitude of localized fish kills by increasing the number and extent of areas affected by pre-dawn DO declines during July-October. Use of the proposed 70% exceedance forecast to predict inflow year types underestimates inflow predictions in 7 out of 10 years, and will result in the management of UKL for drier year types and lower lake levels with adverse effects on water quality and suckers more often than actual inflows would warrant.

The operation of Link River Dam is likely to periodically increase storage of nutrient-rich, spring storm inflows above the hydrologic baseline in UKL. These additional nutrients are likely to increase summer algal biomass, which during bloom decline leads to adverse water quality,

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[1]Jeopardy is defined in 50 CFR §402.02 as, "... to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species."

especially low DO levels, and can lead to catastrophic fish die-offs similar to those that resulted in the loss of an estimated 80-90% of the adult sucker population in UKL during the 1990's under certain environmental conditions. Such events, although unpredictable in frequency, pose a major risk to survival and recovery of the UKL sucker populations.

In summary, Project effects on UKL water quality are likely to appreciably increase the risk of fish kills that will reduce the numbers of suckers in UKL.

7.3 Sucker Habitat Loss in Upper Klamath Lake

The proposed action is likely to have significant adverse effects on sucker habitat in UKL during some inflow year types:

The proposed lake levels reduce late summer/fall adult sucker habitat by as much as 50% in dry and critically dry years. This will exacerbate adult sucker habitat limitations caused by areas of adverse or lethal water quality during the summer and fall when lake levels and habitat availability are at their lowest.

During dry and critically dry inflow year types, shallow water depths in August-October reduce sucker access to water quality refuge areas in the northwest lobe of UKL which is likely to result in higher adult sucker mortality during large-scale fish kills.

The proposed minimum lake levels during the critically dry inflow year type will substantially limit in-lake sucker spawning habitat and are likely to cause loss of sucker reproduction in those years.

During the period from August through October of below average, dry, and critically dry years there is likely to be a substantial loss of late-season juvenile sucker habitat and a high risk of year-class failure in critically dry years.

Although the proposed action will generally provide sufficient habitat for larval suckers in most inflow year types, there is a high risk of larval year-class failure for the Williamson River spawning population of suckers as a result of lake level management proposed for the critically dry inflow year type.

In summary, the magnitude of anticipated sucker habitat loss under certain conditions is likely to appreciably reduce the reproduction and numbers of suckers at UKL.

Collectively, the significance of these adverse effects are magnified because of the depressed condition of the UKL sucker population following three major fish kills during the 1990s that resulted in the loss of an estimated 80-90% of the adult sucker population in UKL. Although there is evidence that over the last four years suckers in UKL are slowly increasing in numbers, the rate of this increase is sufficiently slow that it will require several additional sub-adult cohorts entering the adult population to replace those adults that were lost. This is especially the case for the SNS, which has shown only a slight population increase since 1997. Although the number of adult suckers in UKL may increase, the reproductive potential of newly recruited young spawners, until they have additional time to grow and mature, will not be equivalent to the larger older adults they replace. Available information indicates that only 2 or 3 significant recruitment events (sub-adults entering the adult spawning population) have happened in the last 17 years. At this rate, it may be a decade or more before adult sucker population numbers and reproductive potential are as high as they were prior to the die-offs of the 1990's.

In order for the UKL populations of the LRS and the SNS to persist in the currently hypereutrophic condition of the UKL ecosystem, they must be able to successfully reproduce and recruit new spawners into the adult population to compensate for the recurring loss of mature individuals resulting primarily from fish kills. To do this requires reducing entrainment and the effects of adverse water quality on the suckers and their habitat. If the occurrence of major fish kills is more frequent than significant recruitment events, the populations of the LRS and the SNS will continue to decline.

The fate of sucker populations over the next 10 years and beyond will be determined by the balance between the frequency and magnitude of fish kills and entrainment, and the frequency and magnitude of recruitment to the adult spawning population. For the reasons listed above, the proposed action will adversely affect that balance to the degree that it constitutes an appreciable reduction in the likelihood of both the survival and recovery of the LRS and the SNS by substantially reducing their reproduction and numbers at UKL under certain conditions. Therefore, the Service concludes that operation of the Klamath Project, as proposed, is likely to jeopardize the continued existence of the Lost River and shortnose suckers.

8.0 REASONABLE AND PRUDENT ALTERNATIVE

Regulations implementing section 7 define reasonable and prudent alternatives (RPAs) as alternative actions identified during formal consultation that: (a) can be implemented in a manner consistent with the intended purpose of the action; (b) can be implemented consistent with the scope of the Federal agency's legal authority and jurisdiction; (c) are economically and technically feasible; and (d) would avoid the likelihood of jeopardizing the continued existence of listed species or result in the destruction or adverse modification of critical habitat (50 CFR §402.02). An RPA (with 3 elements) to the proposed operation of the Project is described below.

8.1 Adaptive Management

Adaptive management is an important element of this RPA. Adaptive management allows Reclamation flexibility in implementing the proposed action while providing beneficial actions to remove adverse Project effects to the LRS and the SNS. As part of this RPA, studies are required to ensure that the Project is operated in a manner that is compatible with the conservation needs of the LRS and the SNS. The results of these studies are used to formulate remedial actions to remove or reduce these adverse effects. As these remedial actions are implemented, their beneficial effects on the LRS and the SNS are monitored, and corrections made to the actions as indicated. Thus, the remedial actions are fine tuned to best benefit the species by removing adverse Project effects by the most efficient means possible. Adaptive management benefits the species and allows the action agency to save time and expense thus avoiding ineffective, unnecessary use of agency resources.

In the following RPA element, adaptive management is used: Element 3a - dissolved oxygen risk assessment; Element 3 b - flood-induced nutrient inflow assessment; and Element 3c - UKL sucker water quality refuge areas.

Element 1. Reduce Effects of Adverse Water Quality and Habitat Loss in UKL Resulting From Project Operations by using a 50% Exceedence Forecast to Reduce the Threat of Adverse Water Quality in Late Summer

Reclamation shall manage UKL by using the proposed four-step process to determine water year-type, as described in Table 5.1 of the BA (Above average - 4139.8, Below average - 4138.9, Dry - 4138.2, and Critically dry - 4137.1) except that a 50% exceedence factor shall be used rather than a 70% exceedence factor.

Using the 50% exceedence factor will improve the accuracy of inflow forecasts and ensure that lake depths are based on actual inflow and not managed at artificially low levels. Improving the accuracy of inflow forecasts will reduce the adverse effects of shallow lake depths on suckers and increase available habitat, while still ensuring that appropriate irrigation needs are met as proposed.

This RPA element reduces the adverse effects of the proposed action on sucker numbers and reproduction in a manner that is compatible with the conservation needs of the LRS and the SNS by providing more habitat for all sucker life-stages and reducing the threat of adverse water quality caused by shallow water depths in late summer. The additional habitat provided under this RPA element is likely to improve sucker survival which will increase their numbers and reproduction. More spawning and rearing habitat is likely to improve larval and juvenile production. Greater water depth in adult habitats is likely to improve sucker access to water quality refuge areas which is likely to improve their survival during adverse environmental conditions.

Element 2. Reduce Sucker Entrainment at Link River Dam

2a. *Reduce Entrainment of Juvenile, Sub-adult, and Adult Suckers at Link River Dam and Hydropower Diversions*

Reclamation shall develop and implement a plan to substantially reduce entrainment of suckers >30 mm in length past the Link River Dam, including the dam gates and hydropower diversions. The Service recommends inclusion of PacifiCorp in development and implementation of the plan. A draft entrainment reduction plan shall be provided to the Service for review and comment by August 1, 2002. Reclamation shall implement the approved plan by April 1, 2003. Examples of possible options for reducing entrainment of juvenile, sub-adult, and adult suckers include: reductions in diversions through one or both penstocks during key periods of juvenile entrainment (July-September); screens to exclude sub-adults and adults; in-stream barrier walls that prevent juvenile, sub-adult, and adult suckers from moving downstream along the bottom; and diversion intakes that withdraw water from the surface, rather than from near the bottom where post-larval suckers typically swim.

Entrainment by Project water diversions involves tens of thousands of juvenile and hundreds to thousands of sub-adult and adult suckers each year, directly reducing the population and preventing successful recruitment of young fish into the adult spawning populations. The populations of the LRS and the SNS in UKL are currently subject to entrainment at A-canal and at the Link River Dam. Reclamation's proposed screening of the A-canal by 2003 will reduce entrainment losses of post-larval suckers. However, entrainment will continue at the Link River Dam. Once the A-canal screen is operational and bypass of suckers occurs into the reach above the Link River Dam, the number of suckers entrained at the dam may further increase if by-passed suckers move a short distance downstream. Sucker passage at Link River Dam, proposed by Reclamation to be in place by 2006 or sooner, should allow adult suckers to return upstream past the dam, but it is uncertain how many young suckers will survive adverse downstream conditions for the 4-9 years necessary to mature and then return to UKL to spawn.

This RPA element reduces the adverse effects of the proposed action on sucker numbers and reproduction in a manner that is compatible with the conservation needs of the LRS and the SNS by reducing the loss of post-larval sucker life-stages by entrainment.

Element 3. <u>Study Factors Affecting Water Quality Leading to Fish Die-offs and Access to Refuge Habitat in UKL; Implement Actions to Reduce Die-off Frequency and Magnitude and Increase Access to Refuge Habitat in UKL; Assess Ongoing Sucker Population Monitoring and Implement needed Improvements and Develop Annual Assessment Report</u>.

3a. *Develop a Dissolved Oxygen Risk Assessment Model for UKL and Incorporate Results into Project Management*

Reclamation shall develop a risk assessment model that will aid in the prediction of adverse DO concentrations in relationship to water depths in UKL, similar to the one developed by Miranda et al. (2001). This risk assessment model will provide an improved basis for managing summer lake depths. Much of the necessary data for the model could be derived from other ongoing studies on UKL water-quality, with additional data on seasonal water column DO consumption and any SOD measurements developed as needed. We recommend that the Water Resources Division (WRD) of the USGS be invited to participate in developing the model and gathering necessary data, owing to their expertise in water quality assessment. Reclamation shall also consult the Klamath Tribes and ODEQ because of their expertise and knowledge of UKL water quality. Two additional experts in this field shall also be consulted, both in developing the model and in its peer-review. By July 1, 2002, Reclamation shall have developed, for Service for review and concurrence, a draft plan that will outline how the necessary data will be collected and how the modeling will be performed. Modeling data shall be collected in 2002, and, if necessary, in 2003, and the model shall be tested and validated in 2003, and, if necessary, in 2004. Reclamation shall incorporate the results of this risk assessment model, as soon as it is completed, with Service concurrence, into Project-related management of UKL.

The principal populations of the LRS and the SNS in UKL are subject to periodic catastrophic and annual localized mortality events caused by adverse water quality. In the 1990's such die-offs killed an estimated 80-90% of the adult population. We are, at present, unable to predict or prevent such events. It is crucial to determine what role Project management of UKL has on the mechanisms that cause adverse water quality and in finding solutions that will allow Reclamation to avoid or reduce catastrophic sucker mortality events.

This RPA element reduces the adverse effects of the proposed action on sucker numbers and reproduction in a manner that is comparable with the conservation needs of the LRS and the SNS by developing information that can be used to reduce the threat of low DO levels which are a primary contributor to adverse water quality and catastrophic fish die-offs in UKL. If fewer suckers of all life-stages die from adverse water quality, more will contribute to sucker population sizes and reproduction.

3b. *Assess the Relationship between Flood-Induced Nutrient Inflow and Fish Kills and Incorporate Findings into Project Operations*

Reclamation shall assess the potential relationship between flood-induced, nutrient inflows into UKL and catastrophic fish die-offs, hypothesized by Wood (2002). As part of this assessment, Reclamation shall develop a test where operation of facilities is changed and water quality changes monitored to determine the potential for minimizing storm-induced nutrient inflow effects. Reclamation shall prepare a draft report on the subject and present it to the Service for review and comment on or before October 1, 2003. This report should critically review any available data that might support or refute the hypothesis. It should also describe any studies that are need to better determine if the hypothesis is valid. Any needed studies shall be implemented in 2003, and, if necessary, in 2004. We recommend that Dr. Tammy Wood, USGS-WRD, be invited to assist in developing the report because Dr. Wood proposed the hypothesis and is an expert on UKL water quality. Reclamation shall consult the Klamath Tribes and ODEQ because of their expertise and knowledge of UKL water quality. At least two additional experts in this field shall be involved, both in developing the report and in its peer-review. The final report shall be provided to the Service for review and comment within 6 months after any studies are completed. Reclamation shall incorporate the findings of the report into annual operation plans for the Project.

This RPA element reduces the adverse effects of the proposed action on sucker numbers and reproduction in a manner that is comparable with the conservation needs of the LRS and the SNS by developing and applying information to reduce the threat of adverse water quality in UKL. If fewer suckers of all life-stages die from adverse water quality, more will contribute to sucker population sizes and reproduction.

3c. *Assess and Manage UKL Sucker Water Quality Refuge Areas*

Reclamation shall undertake a study and develop a draft report with management recommendations that addresses sucker use of water quality refuge areas in UKL as they relate to their conservation needs and management of water depths in UKL. The role of water quality refuge areas for suckers in UKL must be better understood because it has important ramifications for adult sucker survival during adverse water quality conditions, and it could be adversely affected by Project management. The objectives of the study and report should be to determine: 1) the locations and sizes of areas of improved water quality during the August-September period when water quality is most adverse; 2) how adult suckers movements relate to adverse water quality; and 3) how water depths affect potential sucker use of water quality refuge areas. We anticipate that 2 years of directed studies will be needed to fully assess this issue. Reclamation shall submit annual progress reports to the Service on or before January 30, until the study is completed. A draft report summarizing the results of the study shall be provided to the Service and Klamath Tribes for review and comment within 6 months of completion of the field studies. The report shall include management recommendations for UKL that will provide adequate sucker access to water quality refuges areas when needed. The findings of the final repot shall be integrated into Project operation plans, as appropriate. We recommend that USGS-BRD and WRD, be involved in this study owing to their expertise in radio-telemetry and water quality studies.

These actions are necessary to adequately address adult sucker survival in UKL. This RPA element reduces the adverse effects of the proposed action on sucker numbers and reproduction in a manner that is comparable with the conservation needs of the LRS and the SNS by developing information that can be used to determine what water depths are needed to ensure that adult suckers have adequate access to water-quality refuge areas during periods of low DO concentrations. If fewer adult suckers die from adverse water quality, more will contribute to sucker population numbers and reproduction.

We understand that Reclamation has funded this study for 2002, but it was not part of the proposed action. Because the Service feels this study is crucial to reduce adverse effects of UKL management, we have therefore included the study as an RPA element.

3d. *Assess Ongoing Sucker Population Monitoring and Implement needed Improvements and Develop Annual Assessment Report.*

Reclamation shall assess on-going sucker population monitoring and implement recommended improvements in order to ensure that the best possible sucker status information is available for adaptive management of UKL sucker populations. Reclamation, in cooperation with the Service, Klamath Tribes, USGS, and OSU fishery biologists, shall convene a working group to review existing sucker monitoring and population assessments and shall develop a draft plan for Service review and comment that will improve annual assessments of: (1) spawning indices; (2) age 0 year class strength; and (3) sub-adult and adult population status. Two outside experts in fish population monitoring and/or population modeling shall be asked to review and comment on the draft plan. The working group will consider the need to develop a population dynamics model to assist with status assessment. The draft plan shall be sent to the Service by April 1, 2003. Once the plan is approved by the Service it will be implemented by Reclamation. An annual population assessment report shall be provided to the Service, Klamath Tribes, and ODFW by January 30th.

3e. *Sucker Die-off Monitoring and Assessment*

Reclamation, in cooperation with the Service, Klamath Tribes, USGS, and OSU fishery biologists, shall develop and implement a sucker die-off and assessment plan. The plan will assist Reclamation and the Service to better assess the magnitude of a major die-off, should one occur. The draft plan shall be sent to the Service for review and comment by July 1, 2002. The die-off monitoring plan will be implemented if a major fish die-off occurs.

*****Note: In the Final BO A Table Will be Inserted Here Showing RPA and RPM Implementation Schedule*****

9.0 INCIDENTAL TAKE STATEMENT

This Incidental Take Statement applies to incidental take of the LRS and/or the SNS resulting from the operation of the Project for a 10-year period. It replaces the Incidental Take Statements for all previous BOs addressing Reclamation's operation of the Project, except for the 1995 BO on the use of pesticides. The Service has notified Reclamation on the need to reinitiate consultat6ion on the 1995 BO, and Reclamation has agreed to provide the Service with a draft BA in the next month or so.

Sections 4(d) and 9 of the Act, as amended, prohibit taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct) of listed species of fish or wildlife without a special exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harassment is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is any take of listed animal species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by Reclamation so they become binding conditions of Project authorization for the exemption under 7(o)(2) to apply. Reclamation has a continuing duty to regulate the activity that is covered by this incidental take statement. If Reclamation (1) fails to adhere to the terms and conditions of the Incidental Take Statement through enforceable actions, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of 7(o)(2) may lapse. In order to monitor the impact of incidental take, Reclamation must report the progress of the action and its impact on the species to the Service as specified in the Incidental Take Statement in accordance with 50 CFR §402.14(i)(3).

The Service developed this Incidental Take Statement based on the premise that the RPA will be implemented. In operating the Project as modified under the RPA, the Service anticipates that the LRS and/or the SNS could be taken in the form of capture, kill, harm, and harass.

9.1 Quantification of Incidental Take

The Service anticipates that take of LRS and/or SNS adults, sub-adults, juveniles, and larvae will occur in the form of capture, kill, harm, and harass as a result of operating the Project in accordance with the RPA set forth in this BO. We anticipate that such take will likely occur as a result of the following actions related to Project operations each year for the 10-year period of the proposed action**.**

9.1.1 Entrainment at Project Diversions

1. Entrainment resulting in kill and harm of up to an estimated 3 million larval suckers annually at the A-Canal, C-Drop harvest facility, Link River Dam and other Project water diversions;

2. Entrainment resulting in kill and harm of up to an estimated 50,000 post-larval suckers annually at the Link River Dam and other Project water diversions;

3. Entrainment resulting in kill and harm of up to an estimated 1,000 post-larval suckers from Clear Lake and Gerber Reservoir into the Lost River and any associated water delivery systems;

4. Entrainment resulting in kill and harm of up to an estimated 100 post-larval suckers from Tule Lake via pumps or diversions into associated water delivery systems; and

5. Capture via salvage operations in Project canals resulting in harm and harassment of up to an estimated 10,000 sub-adult and adult suckers.

9.1.2 Adverse Water Quality Resulting From Project Operations

1. Kill and harm of an unquantified number of suckers inhabiting the Project lakes and reservoirs when water quality or quantity is reduced to stressful levels by lowered water depths; and

2. Kill and harm of an unquantified number of suckers from the adverse effects of poor water quality, increased predation, and desiccation of suckers trapped in the water delivery systems including canals, drains, fields, head-gates, turnouts and pumps.

The Service is unable to quantify the number of suckers that will be taken as a result of Project-related adverse water quality because it is impossible to document mortality of larvae and juveniles since they are so small, and as they become ill or die, many are likely consumed by fish-eating birds. Documenting mortality of sub-adults and adults is also problematic because those suckers that die and do not float cannot be seen from a boat owing to poor visibility.

9.1.3 Habitat Alteration in Project Lakes and Reservoirs as a Result of Project Operations

1. Harm of suckers through loss of habitat resulting from sedimentation of Tule Lake sump as an indirect effect of the proposed action, reducing water depths below that used by adult suckers and blocking sucker access to upstream spawning areas; and

2. Kill and harm of an unquantified number of adult suckers due to habitat loss in UKL, Clear Lake, and Gerber Reservoir caused by Project water diversions.

The Service is unable to quantify the number of suckers that will be taken as a result of habitat loss owing to diversion of water from Project lakes and reservoirs because currently there are no estimates of the numbers of suckers using the affected habitat.

The BA does not address, nor does the Service have any information on the extent of incidental take of the LRS and the SNS caused by the Straits Drain which contributes to poor water quality in the Keno Reservoir.

9.1.4 Summary

Implementation of the proposed action in accordance with the RPA will likely result in substantial levels of take through entrainment of millions of larval, tens of thousands of juvenile, and hundreds to thousands of sub-adult and adult suckers at Project dams and water diversions. Harm will also occur at the six primary Project dams, because the dams**:** physically isolate sucker populations; prevent genetic exchange between populations; block access to essential spawning, larval, and rearing habitat; cut off escape from adverse conditions downstream; and prevent the return of entrained suckers to upstream habitat and spawning areas. Project dams also are likely to result in take by harm by increasing storage of nutrient-rich storm inflows above the hydrologic baseline. These additional nutrients are likely to increase summer algal biomass in UKL, which adversely effects water quality and could lead to catastrophic fish die-offs similar to those that resulted in the loss of an estimated 80-90% of the adult sucker population in the 1990's. Diversion of water from Project lakes and reservoirs is also likely to result in take by harm by reducing water depths, adversely affecting water quality and, reducing sucker access to water quality refuge areas, spawning, and larval and juvenile rearing habitats. Adverse water quality directly leads to sucker mortality or reduced fitness. Adverse water quality also alters the natural pattern of disease and parasitism within the sucker populations, likely increasing their frequency and intensity.

Reduced depths in Project lakes and reservoirs will also likely make larval and juvenile suckers more susceptible to fish predation by forcing them to use habitat away from the protective cover of shallow water and any associated wetlands. Lower lake levels also likely make juvenile and adult suckers more vulnerable to predatory birds because of the shallow depths in some Project reservoirs, such as Clear Lake, Tule Lake sump, and UKL.

The annual, historical take of suckers as a result of Project operation has been approximately 2-4 million larvae (Project-wide), 0.1-0.3 million juveniles, and probably 1-10 thousand sub-adult or adult suckers. This estimate is approximate owing to temporal limitations in sampling, sampling gear biases, species identification difficulties, and other factors that contribute to uncertainty. However, the figures are probably sufficiently accurate to represent the correct order of magnitude (within a factor of 10). These estimates are limited to entrainment losses and do not include other potential sources of mortality due to water management and resultant adverse water quality effects and habitat loss, which are not quantifiable at this time. This level of historical take is clearly significant since it represents a similar order of magnitude to the annual production of juveniles in UKL and has resulted, in part, in the Service's conclusion that the proposed action likely jeopardizes the continued existence of the species.

After July 2003, the take of post-larval suckers will be reduced substantially by screening of the A-Canal. However, juvenile suckers screened from the A-Canal will still be subject to entrainment at the Link River Dam just downstream. Implementation of the RPA will further reduce larval entrainment at both diversions and post-larval entrainment at the Link River Dam, but the expected reductions cannot be quantified at this time. Screening at Clear Lake will be completed during April 2002 and will reduce entrainment there as well. With implementation of the RPA and screening at A-Canal and Clear Lake Dam, the Service anticipates that annual Project-wide incidental take would be reduced to approximately 3 million larvae, fewer than 50,000 juveniles and fewer than 1,000 adult suckers.

The Service establishes the following reasonable and prudent measures (RPMs) to minimize the impacts of the anticipated incidental take of listed suckers discussed above.

9.2 Effect of the Take

Take of up to 3 million larvae, 50,000 juveniles, and fewer than 1,000 sub-adult and adult LRSs and SNSs annually is likely to have a significant adverse effect on sucker populations but it is not anticipated to jeopardize the continued existence of these species because: (1) take will consist mostly of larvae which typically have a natural mortality greater than 99%, due to starvation and predation; (2) historical levels of entrainment due to Project operation have been greater but sucker recruitment were apparently sufficient to maintain the population prior to the population crash of the1980's that resulted in listing; (3) the recruitment of two or three cohorts over the last 17 years into the UKL adult sucker populations demonstrated that cohorts occasionally developed under higher levels of historical take; (4) any suckers entrained past the Link River Dam that survive to adulthood downstream should be able to re-enter UKL beginning in 2006, when the Link River Dam fish ladder is operational; (5) some take will be in the form of harm and will not necessarily lead to mortality but some take resulting from adverse water quality and sedimentation will be in the form of both harm and kill; (6) salvage of suckers in Project canals provides a short-term solution that can reduce the adverse effects of take, other than direct mortality, prior to completion of entrainment reduction measures; and (7) restoration of larval and juvenile habitat in rearing areas of UKL, combined with lake management that approaches the natural baseline hydrograph in most years, should increase survival of larvae and juveniles and could reduce the numbers that move downstream due to lack of habitat, thereby helping to compensate for entrainment losses.

This analysis of the effects of the take assumes that the current trend in increased adult sucker population sizes continues, recruitment will be adequate to offset reductions in adult numbers by fish kills, and efforts to improve water quality throughout the Upper Klamath Basin continue and are successful. If these assumptions are shown to be invalid, Reclamation will need to reinitiate formal consultation on the Project.

9.3 Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the impacts of incidental take of the LRS and the SNS:

1. Minimize entrainment resulting from Project operations.

2. Minimize adverse water quality resulting from Project operations.

3. Minimize habitat alteration in Project lakes and reservoirs resulting from Project operations.

9.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, Reclamation must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

In all of the following RPMs, adaptive management is used to allow Reclamation maximum flexibility while provided maximum benefit to the species.

RPM 1: <u>Minimize Entrainment Throughout the Project</u>

1a. *Assess and Implement Methods to Reduce Entrainment of Larval Suckers*

Reclamation shall assess and implement practical approaches to substantially reduce entrainment Project diversions. A draft entrainment reduction plan shall be provided to the Service for review and comment on or before August 1, 2002. Reclamation shall implement the approved entrainment reduction by April 1, 2003. Examples of possible options for reducing entrainment of larval suckers include: placement of floating curtains to deflect surface-oriented larvae during key periods of larval entrainment (April-July); and diversion intakes that withdraw water from below the surface during that period. Reclamation has already proposed implementing similar measures at A-Canal as part of its proposed operation of the Project for April and May 2002, but this project feature was not a part of the proposed 10-year operation plan.

Until permanent screening is in place at A-Canal, Reclamation shall continue to implement placement of a curtain for larvae as set forth in the Interim BO for operations from April 1, 2002 through May 31, 2002. The curtain and netting shall be checked every week for holes and these shall be immediately repaired.

1b. *Assess and Implement Methods to Reduce Entrainment of Juvenile, Sub-adult, and Adult Suckers at Project Diversions*

Reclamation shall develop and implement a plan to substantially reduce entrainment of suckers >30 mm in length into Project diversions other than A-Canal and Link River Dam, which are considered under the Project as proposed (A-Canal) and the RPA (Element 2), including the dam gates and irrigation diversions. A draft entrainment reduction plan shall be provided to the Service for review and comment by August 1, 2002. Reclamation shall implement the approved plan by April 1, 2003. Examples of possible options for reducing entrainment of juvenile, sub-adult, and adult suckers include: reductions in diversions during key periods of juvenile entrainment (July-September); screens to exclude sub-adults and adults; in-stream barrier walls that prevent juvenile, sub-adult, and adult suckers from moving downstream along the bottom; and diversion intakes that withdraw water from the surface, rather than from near the bottom where post-larval suckers typically swim.

1c. *Implement Methods to Reduce Entrainment of Juvenile, Sub-adult, and Adult Suckers at A-Canal Prior to Completion of the Proposed Fish Screen*

Until permanent screening is in place at A-Canal, Reclamation shall continue to implement placement of netting for post-larvae as set forth in the Interim BO for operations from April 1, 2002 through May 31, 2002. The netting shall be checked periodically for holes and these shall be immediately repaired.

Entrainment by the A-Canal involves tens of thousands of juvenile and hundreds to thousands of sub-adult and adult suckers each year, directly reducing the population and preventing successful recruitment of young fish into the adult spawning populations.

This RPM reduces the adverse effects of the proposed action on sucker numbers and reproduction in a manner that is compatible with the conservation needs of the LRS and the SNS by reducing the loss of suckers by entrainment. If fewer suckers are lost, more will likely survive and contribute to sucker population sizes and increased reproduction.

RPM 2: <u>Minimize Adverse Water Quality Resulting From Project Operations</u>

2a. *Monitor, Implement, and Report on Water Quality in Project Delivery Area*

Reclamation shall monitor water quality in all Project lakes and reservoirs, and other features such as canals and drains, as well as water bodies affected by Project operations where water quality is likely to result in appreciable take of the LRS and the SNS. This includes Clear Lake, Gerber Reservoir, the entire Lost River and Tule Lake sump, UKL and Link River to Keno Dam and key canals and drains where incidental take is likely to occur. Key parameters to monitor include: temperature, DO, pH, and un-ionized ammonia. Reclamation, with available assistance of the Klamath Tribes, appropriate State agencies, EPA, and water quality experts from USGS, state universities, and one or more water quality experts designated by Reclamation representing its contractors, licensees, or permittees, shall develop a draft water-quality monitoring plan to be presented to the Service for review and approval by a mutually agreeable date. Comments shall also be requested from State resource agencies, and interested Indian tribes. Annual monitoring reports shall be sent to the Service, BIA, NCWQCB, ODEQ, ODFW, CDFG, and interested Indian Tribes by January 30th of each year. Reclamation, in consultation with the Service, BIA, interested Indian Tribes, and State agencies listed above, shall determine if, based on the annual monitoring reports, what additional data needs to be collected.

Reclamation, in coordination with the Service, interested Indian Tribes, appropriate State and Federal agencies, Universities, and/or other parties, shall develop and implement a Project-wide plan to reduce the adverse effects of the Project on water quality in areas occupied by endangered suckers. The plan will describe or provide: (1) an assessment of the effects of Project management on water quality; (2) a list of all Project features that adversely affecting water quality and describing the extent and mechanism of effects; (3) a description of measures aimed at reducing adverse effects and an implementation schedule; and (4) a monitoring plan to measure effectiveness of the plan. Annual progress reports shall be sent to the Service, ODFW, CDFG, and Klamath Tribes by January 30th of each year, until implementation of the plan is successfully completed. Reclamation shall implement actions approved by the Service based on an implementation schedule developed through consultation.

RPM 3: <u>Minimize Habitat Alteration in Project Lakes and Reservoirs as a Result of Project Operations</u>

3a *Provide Adequate Link River Habitat and Assess Sucker Habitat Needs in the Link River and Downstream in Lake Ewauna and the Keno Reservoir*

Reclamation shall take actions under its authority to ensure that water quality in the Link River and adjacent Lake Ewauna is adequate to protect suckers by providing minimum flows of at least 250 cfs through Link River Dam gates during the summer when water quality is adverse. These flows are needed to increase available sucker habitat in the Link River and to ensure that water entering lake Ewauna is fully oxygenated. By passing more water down the Link River it will be oxygenated as it passes over the rocks and cascades that occur in the channel.

Reclamation shall determine how DO levels change with flows from Link River Dam by continuously monitoring DO and levels of flow during June through October 2002. Reclamation shall use the results of those studies and any other available information to develop minimum flow schedules. Reclamation shall provide the Service with a report on the water quality/flow monitoring and make recommendations on necessary minimum flows based on an analysis of the data. Reclamation and the Service shall review the report and determine what findings and actions may be implemented to maintain minimum flows based on recommendations in the report and input from the Service, ODEQ, ODFW, and the Klamath Tribes. Reclamation shall implement actions approved by the Service.

Reclamation shall undertake a Link River-Lake Ewauna-Keno Reservoir habitat study to determine how Project operations affect sucker habitat in the Link River and Lake Ewauna-Keno Reservoir area. The study shall address the ability of suckers to reside in the Link River and Lake Ewauna-Keno Reservoir areas. It shall also assess any passage problems that might prevent movement of suckers up the Link River and ultimately around the Link River Dam. Such a study is likely to take 2 years and a draft final report shall be provided to the Service by January 1, 2004, with findings and recommendations on ways to reduce Project impacts. Reclamation and the Service shall review the report and determine what findings and actions may be implemented. Reclamation shall implement actions approved by the Service based on an implementation schedule developed through consultation.

3b. *Provide Adequate Habitat Below Clear Lake and Gerber Reservoir Dams*

Reclamation (in coordination with affected irrigation districts, BLM, and CDFG and ODFW) shall provide annual minimum in-stream flows below Clear Lake and Gerber Reservoir dams following termination of irrigation releases, if water levels in the reservoirs are above minimums deemed necessary to protect suckers by Reclamation and the Service. Minimum flows are needed to provide adequate habitat (quality and quantity) below the dams and to provide adequate flows in spring for spawning. Likely flows would be approximately10 cfs, both winter and spring, depending on accretion flows. A draft in-stream flow study plan shall be prepared by Reclamation and provided to the Service, BLM, and CDFG and ODFW for review and comment. The approved plan shall be used as a basis for determination of necessary minimum in-stream flows. Data collection for this effort shall occur in the fall, winter, and spring of 2002-2003.

Following data collection, Reclamation and the Service shall review the report and determine what findings and actions may be implemented to provide minimum flows by the end of the irrigation season in 2003. Water quality and habitat monitoring will be conducted in 2003 to determine if flows are adequate to protect sucker habitat in downstream reaches of Miller Creek and Lost River, especially to provide adequate spawning habitat. Reclamation shall implement actions approved by the Service. Reclamation shall implement actions approved by the Service based on an implementation schedule developed through consultation.

3c. *Assess Habitat Conditions and Endangered Sucker Needs in the Lost River*

Reclamation (in coordination with affected irrigation districts and CDFG and ODFW) shall prepare a report on sucker habitat use in the Lost River system and document threats to suckers as a result of direct, indirect, or interrelated effects owing to Project operations. A preliminary report using existing data shall identify what additional data are needed and shall be presented to the Service for review and comment. The report shall include recommendations for: management of Reclamation’s Lost River dams to reduce take; improving habitat in the channelized reach in Langell Valley; improving spawning habitat in Big and Bonanza springs; reducing rapid changes in river stage owing to an imbalance between irrigation deliveries and withdrawals; reducing sediment and nutrient loading, especially to Tule Lake; and providing sucker access to spawning areas.

Reclamation, in consultation with the Service, shall determine if, based on the preliminary report, additional data must be collected to prepare a final report. Following completion of the final report, Reclamation and the Service shall review the report and determine what findings and actions may be implement to reduce adverse effects of Project operations to the Lost River. Reclamation shall implement actions approved by the Service. Annual progress reports shall be sent to the Service, ODFW, CDFG, and Klamath Tribes by January 30th of each year, until implementation is successfully completed. Reclamation shall implement actions approved by the Service based on an implementation schedule developed through consultation.

3d. *Determine Habitat Needs for Larval Suckers and Implement Actions to Provide Additional Habitat*

Reclamation shall draft a plan, by a mutually agreeable date, for Service, ODFW, and Klamath Tribes' review, to determine the role of emergent vegetation in larval/juvenile sucker survival and how this relates to water depth management in UKL. Habitat needs for larval and juvenile suckers in UKL, including the lower Williamson River, are not adequately known. This has direct bearing on the conservation needs of the species because an elevation of 4140.0 ft represents a threshold where, at lower levels, emergent vegetation becomes unavailable to larvae and juvenile suckers in UKL and therefore could affect their survival. The plan shall also address emergent wetland restoration needs. Reclamation shall provide the Service, ODFW, and Klamath Tribes with a draft plan for necessary studies by January 30, 2003. Necessary studies shall begin in 2003 and be continued in 2004, if necessary. A final report shall be presented to the Service within six months after completion of the field studies. Reclamation and the Service shall review the report and determine what findings and actions may be implemented. Reclamation shall implement actions approved by the Service. Reclamation shall implement actions approved by the Service based on an implementation schedule developed through consultation.

3e *Determine juvenile habitat distribution in UKL relative to bathymetry and lake elevations.*

Reclamation shall map the distribution and quantity of substrate types in UKL including depths and offshore extent. This information can be used to determine the effects to juvenile habitat availability at various lake levels. Reclamation shall collect and analyze this data in a format that quantifies habitat availability relative to lake levels and management. Reclamation shall provide this analysis to the Service by January 30, 2003.

3f. *Analyze risk to sucker populations from multiple dry and critically dry years and develop management plan to reduce that risk.*

Reclamation shall analyze the risk to sucker habitat needs during multiple dry or critically dry years that might occur with greater frequency than the 1990's. Reclamation shall additionally develop a management plan to reduce this risk and meet long term habitat needs. This has direct bearing on the conservation needs of the species because Reclamation's analysis does not cover a frequency of dry or critically dry years that would be higher than the 1990's. Service believes it would be advantageous to develop a contingency plan for that circumstance.

9.5 Monitoring Requirements Under the Terms and Conditions

When incidental take is anticipated, the terms and conditions must include provisions for monitoring to report the progress of the action and its impact on the species (50 CFR §402.14(i)(3)).

Since there is currently no on-going, Project-wide incidental take monitoring of listed suckers, Reclamation shall develop a draft incidental take monitoring/reporting plan and provide it to the Service by July 30, 2002 for review and comment. Implementation of this plan shall begin as soon as the plan is approved and needs to focus on quantifying as much of the incidental take as feasible. The Service recognizes that incidental take of larvae is difficult to monitor. Also, it may not be feasible to monitor all project activities because of the numerous Project facilities that result in incidental take. The Service will determine what is reasonable, based in part on Reclamation's analysis of what incidental take can be monitored.

Because monitoring will rely on estimates of incidental take developed by appropriate sampling, the plan shall be reviewed by an expert in biostatistics, to ensure the estimates are as accurate as possible. The Service recommends that existing monitoring reports be reviewed by Reclamation to determine how best to proceed. The sampling and statistical analyses must be adequate for Reclamation and the Service to determine if and when incidental take levels are being approached or have been exceeded.

Reclamation shall provide the Service, for review and comment, with a draft incidental take monitoring plan to be implemented upon Service approval. Annual reports will be sent to the Klamath Falls Fish and Wildlife Service Office and to the Service's law enforcement office in Klamath Falls. If Reclamation determines that authorized incidental take is exceeded, this office and the Service's law enforcement office in Klamath Falls must be notified. Reclamation will be responsible for ensuring that its licensees, contractors, or designees do not exceed authorized incidental take levels.

9.6 Reporting Requirements

Upon locating a dead, injured, or sick specimen of an endangered or threatened species, initial notification must be made to the nearest Service Law Enforcement Office. In Oregon, contact the U.S. Fish and Wildlife Service, Division of Law Enforcement, 301 Post Office Building, Klamath Falls, Oregon 97601 (phone: 541/883-6900). In California, contact the U.S. Fish and Wildlife Service, Division of Law Enforcement, District 1, 2800 Cottage Way, Room W-2928, Sacramento, California 95825 (phone: 916/414-6660). Care should be taken in handling sick or injured specimens to ensure effective treatment and care and in handling dead specimens to preserve biological material in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured endangered species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

The Service is to be notified within three (3) working days of the finding of any endangered or threatened species found dead or injured in the Project service area. Notification must include the date, time, and precise location of the injured animal or carcass, and any other pertinent information. In California and Oregon, the Service contact person for this information is Mr. Steven A. Lewis (phone: 541/885-8481). Any LRS or SNS found dead or injured in California shall be provided to the CDFG by calling them at (530) 225-2300.

10.0 CONFERENCE REPORT

Critical habitat for the LRS and the SNS was proposed in 1994, but has not yet been finalized (17 FR 61744). The primary constituent elements identified in the proposal are as follows: (1) water of sufficient quantity and suitable quality; (2) sufficient physical habitat, including water quality refuge areas, and habitat for spawning, feeding, rearing, and travel corridors; and (3) a sufficient biological environment, including adequate food levels, and natural patterns of predation, parasitism, and competition.

Reclamation did not address potential effects to proposed critical habitat in their BA or request a conference report. The following is provided for Reclamation's consideration so that the final operation plan for the Project adequately considers the conservation needs of the LRS and the SNS relative to proposed critical habitat.

10.1 Effects of the Action on Proposed Critical Habitat

The Project lies within or adjacent to all six of the proposed critical habitat units: CHU #1 (Clear Lake and Watershed); CHU #2 (Tule Lake); CHU #3 (Klamath River); CHU #4 (UKL and Watershed); CHU #5 (Williamson and Sprague Rivers); and CHU #6 (Gerber Reservoir and Watershed). The primary constituent elements for these units that are likely to be adversely affected, directly or indirectly, by Reclamation's proposed action are as follows:

CHU #1 (Clear Lake and watershed): seasonal increase in habitat for suckers; reduced water quality, primarily low DO, both in summer and in winter below an ice cover, as a result of low lake levels; creation of enhanced habitat for non-native, predatory fish; and blocked access of downstream fish into Clear Lake and tributary spawning as result of Clear Lake Dam.

CHU #2 (Tule Lake): degraded water quality via increases in temperature, BOD, pH, ammonia, nutrients, pesticides, and sediments, and lowered DO; loss of spawning and rearing habitat in the Lost River; severe sedimentation in the Tule Lake sumps limiting adult habitat and restricting access to upstream spawning sites; population fragmentation; habitat improvements for non-native, predatory fishes; and changes in spawning flow magnitude and duration below Anderson-Rose Dam.

CHU #3 (Klamath River): alterations in flow timing, magnitude, and duration; establishment of non-native, predatory fishes; and water quality degradation including pesticides, and increased temperature, BOD, pH, ammonia, nutrients, and sediments, and lowered DO.

CHU #4 (UKL and watershed): reductions in water surface elevations under certain water year conditions have numerous potential direct and indirect affects to CHU #4's primary constituent elements. Of concern are the potential losses of shoreline spawning areas, young-of-the-year rearing areas of emergent vegetation, and loss of deep-water habitats and water quality refuges areas for older fish; water quality degradation, primarily increased pH and ammonia, and reduced DO; and segregation of habitats. There are also concerns that lower lake levels will reduce connectivity between restored wetlands and UKL at the mouths of the Wood and Williamson Rivers. One of the major purposes of these wetland restorations projects was to reestablish this connectivity and provide lost habitat for age-0 suckers (A. Hamilton, BLM, pers. comm.).

CHU#5 (Williamson and Sprague Rivers): most of this unit is unaffected by the proposed action; however, water level management and its associated impacts will adversely affect spawning access to the Williamson River, larval emigration and quality of rearing areas, and access to refugial areas.

CHU#6 (Gerber Reservoir and watershed): reduced water quality, primarily low DO, both in summer and in winter below an ice cover, as a result of low lake levels; blocked access into the reservoir and upstream spawning area; and creation of enhanced habitat for non-native, predatory fish.

Based on these effects to the primary constituent elements, we conclude that the action, as proposed, will result in the adverse modification of proposed critical habitat for the suckers because of: (1) temporary reductions of water levels by water diversions that preclude sucker use of important seasonal habitats during critical periods of their life cycle; (2) reduction in water levels at the Tule lake Sump caused by sedimentation from upstream, interdependent, agricultural practices; (3) temporary reductions of water quality that preclude sucker use of important seasonal habitats during critical periods of their life cycle; and (4) blockage of passage preventing suckers from using habitats necessary for completion of their life cycle.

Although implementation of the RPA will also address most of the adverse modification effects to proposed sucker critical habitat, the Service needs to further coordinate with Reclamation to completely address this issue. We recognize that our findings relative to proposed sucker critical habitat are strictly advisory and are not binding. However, we believe it is in the best interest of both of our agencies to adequately address effects to proposed critical habitat prior to that proposal being finalized.

11.0 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. The term "conservation recommendations" is defined as suggestions from the Service regarding discretionary measures to: (1) minimize or avoid adverse effects of a proposed action on listed species or critical habitat; (2) conduct studies and develop information; and (3) promote the recovery of listed species. The recommendations provided here relate only to the proposed action and do not necessarily represent complete fulfillment of Reclamation's section 7(a)(1) responsibilities under the Act.

11.1 Endangered Suckers

1. The Service recommends that Reclamation coordinate with BLM, USGS, ODFW, CDFG, the Klamath Tribes, and the Service regarding the potential benefits of establishing a population of Lost River suckers in Gerber Reservoir with brood-stock from Clear Lake. Currently the only sizable LRS population in the Lost River sub-basin is in Clear Lake and this population is vulnerable to droughts.

2. The Service recommends that Reclamation offer to serve as a clearing house for water quality data from the Upper Klamath Basin, especially for those basins which are directly affected by water quality in Project lakes, reservoirs, rivers, canals, and drains. Reclamation is the agency with the most control of water in the upper basin. Proactive efforts to share data among all interested parties would improve the efficiency of existing monitoring and reporting efforts. This would make data more available to anyone and would facilitate water quality management. Currently, data are scattered among numerous agencies and organizations.

3. Fish passage at Chiloquin Dam is believed to be inadequate due to a poorly functioning fish ladder. The Service recommends that Reclamation work with the Service, The Klamath Tribes, the Modoc Irrigation District, and others to secure funding to improve passage. If implemented, this could provide additional valuable spawning habitat for UKL suckers.

4. The Service recommends that Reclamation work with the Tule Lake NWR staff and irrigation districts to develop a plan by a mutually agreeable date that will protect suckers in the Tule Lake sump from the adverse effects of sedimentation and poor water quality. The plan is needed to ensure water depths are adequate for suckers and allow varying water levels so that emergent vegetation can be reestablished. Sedimentation is reducing water depths in the sump by about 5 inches per decade. Over the last 30 years, under a management regime that allowed for only a one foot annual fluctuation in water levels, Tule Lake wetland areas have declined dramatically, including areas with bulrush. These types of habitat are essential to provide for sucker survival, reproduction, and the primary constituent elements of their proposed critical habitat.

5. The Service recommends that Reclamation coordinate with the EPA and States of California and Oregon on the Lost River TMDLs, scheduled to be completed about 2004 or 2005. We believe this coordination would be beneficial because the hydrology and water quality of the Lost River is significantly affected by Project operations and Reclamation might be able to assist the EPA and States with data that would improve the TMDL and reduce its costs.

6. The Service recommends that Reclamation, in coordination with the Klamath Tribes, and ODFW, implement a pilot project directed to enhance sucker spawning at known spawning sites along the eastern shoreline of UKL. The project should look into the feasibility of supplementing spawning gravel into areas where gravel might be limiting, especially at deeper depths. Hatch

boxes and emergence traps could be used to monitor egg deposition and hatching success. If the pilot project is successful, a larger-scale attempt should be considered at one or more of the sites.

7. The Service recommends that Reclamation consider developing an operations plan for Agency Lake Ranch that optimizes water quality benefits of the developing wetlands, on the basis of studies on water quality benefits, especially nutrients and humic substances. This information may be used to develop an operations plan that makes the best use of these wetlands.

8. The Service recommends that Reclamation develop and implement a plan that maximizes the efficient delivery and use of water within the Project delivery area using local expertise from water users, agricultural extension staff, agricultural experiment stations as well as the best available scientific and commercial information. The draft plan should be peer reviewed by outside experts in the field and comments should be elicited from the Service, Klamath Tribes, ODFW and CDFG. Incorporation of findings from the report into operation plans is recommended.

11.2 Other Species of Concern

1. For conservation recommendations regarding bald eagles, please refer to that section of this BO addressing bald eagles.

2. The Service recommends that Reclamation survey all of its properties for the presence of Applegate's milk-vetch (*Astragalus applegatei*) or its suitable habitat.

3. The Service recommends that Reclamation survey for spotted frogs (*Rana pretiosa*) on its Agency Lake Ranch property and consider if it could develop suitable habitat there for this species as a conservation action.

In order to be kept informed of actions that either minimize or avoid adverse effects or that benefit listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

12.0 STATUS OF THE BALD EAGLE

12.1 Species description and life history

The bald eagle is a generalized predator/scavenger primarily adapted to edges of aquatic habitats. It weighs approximately 12 pounds and has a wingspan of 6-7 feet. Its primary foods, in descending order of importance, are fish (taken both alive and as carrion), waterfowl, mammalian carrion, and small mammals. The species is long-lived, and individuals do not reach sexual maturity until 4 or 5 years of age. Bald eagles nest in large trees near and usually within sight of large bodies of water. Nests are constructed of large sticks, are typically 4 ½ feet wide and 3 feet deep, are used year after year and may attain weights of several hundred pounds. The nest occasionally becomes large enough and heavy enough to break off supporting limbs. Often eagles have an additional alternate nest in their territory (Stalmaster 1987). They can occupy nesting territories and nests for decades. Eagles generally mate for life but will replace lost mates readily. Eagles lay an average of 1-3 eggs and if no unusual circumstances exist, all hatch. If adequate prey is not available during brooding only the largest nestling may survive (Kaufman 1996). Young fledge in approximately 10 - 12 weeks but may take another 4 weeks to become proficient at flight. Within several weeks of flight proficiency the young are generally self sufficient and can find food on their own, though they often remain near their parents nesting territory.

Bald Eagles require year-round access to food. Bald eagles that occupy nesting areas without winter access to food migrate from nesting areas to wintering areas with accessible food and night-roosting shelter for thermo-regulation and protection from disturbance. Immature or non-breeding adults often spend a longer period at wintering areas than do breeding adults.

The bald eagle once nested or wintered throughout much of North America near coasts, rivers, lakes, and wetlands.

12.2 Bald Eagle Life History in Pacific Recovery Area

The Pacific States Recovery Area is comprised of the states of Idaho, Nevada, California, Oregon, Washington, Montana and Wyoming. Bald eagle nests in the Pacific States Recovery Area are usually located in uneven-aged stands of coniferous trees with old-growth forest components and are generally located within one mile of large bodies of water. Factors such as relative tree height, diameter, species, form, position on the surrounding topography, distance from water, and distance from disturbance appear to influence nest site selection. Nests are most commonly constructed in Douglas-fir, Sitka spruce and Ponderosa Pine trees, with average heights of 116 feet and diameters of 50 inches at breast height (Anthony et al. 1982, cited in USFWS 1986). Bald eagles usually nest in the same territory and use the same nest year after year. Availability of suitable trees for nesting, foraging and roosting is critical for maintaining bald eagle populations.

Quality of wintering habitat is tied directly to local food sources and characteristics of the area that promote bald eagle foraging. Wintering bald eagles may roost communally in single trees or large forest stands of uneven ages that have some old-growth forest characteristics (Anthony et al. 1982; cited in USFWS. 1986; Dellasala et al.1998; Keister et al. 1987; Keister and Anthony 1983). Some bald eagles may remain at their daytime perches through the night but bald eagles often gather at large communal roosts during the evening. Communal night roosting sites are traditionally used year after year and are characterized by more favorable microclimate conditions. Roost trees are usually the most dominant trees of the site and provide unobstructed views of the surrounding landscape. They are often in ravines or draws that offer shelter from inclement weather (Keister et al.1987). A communal night roost can consist of two birds together in one tree, or more than 500 in a large stand of trees. Roosts can be located near a river, lake, or seashore and are normally within a few miles of day-use areas but can be located as far away from water as 17 miles or more. Prey sources may be available in the general vicinity, but close proximity to food is not as critical as the need for shelter that a roost affords (Stalmaster 1987).

A detailed account of the taxonomy, ecology, and reproductive characteristics of the bald eagle is presented in the Pacific States Bald Eagle Recovery Plan (USFWS 1986).

12.3 Population Dynamics

In the 1900's the nation's bald eagle population underwent an extreme decline, due to losses at all life stages. In 1963, a National Audubon Society survey reported only 417 active nests in the lower 48 States (USDI 1999b). The species suffered population declines throughout most of its range, including Oregon and California, due primarily to habitat loss, shooting, and environmental pollution (USFWS 1986). Adults were lost through shooting, poisoning and electrocution and eggs were lost through eggs breaking during incubation. Current estimations in the lower 48 United States indicate the breeding population exceeded 5,748 pairs in 1998.

12.4 Status and Distribution

On February 14, 1978, the bald eagle was federally listed throughout the lower 48 States as endangered except in Michigan, Minnesota, Wisconsin, Washington, and Oregon, where it was designated as threatened (USDI 1978). The 1978 listing was the result of a decline in the bald eagle population throughout the lower 48 States. The decline was largely attributed to the widespread use of DDT and other organochlorine compounds in addition to destruction of habitat, illegal harassment and disturbance, shooting, electrocution from power lines, poisoning, and a declining food base. In 1995, (except in the above mentioned states where it was already listed as threatened), the bald eagle had recovered significantly enough to be down listed from endangered to threatened (USDOI 1995).

Current range-wide trend data for the bald eagle indicates increasing populations. It is estimated that in the lower 48 states the breeding population exceeded 5,748 pairs in 1998. The recovery has been broadly distributed across the range of the bald eagle. For example in 1984 the 6 states of Florida, Wisconsin, Michigan, Minnesota, Washington and Oregon held 74 percent of the total breeding population. In 1998 that percentage was reduced to 54% (USDI 1999). As their range-wide viability improved, the bald eagle was proposed for delisting in 1999 (USDI 1999b). The Service is considering concerns related to monitoring of nests and protection of wintering areas and other bald eagle issues at this time. No date has been projected for the removal of the bald eagle from the threatened species list.

In the Pacific States Recovery Area, the number of occupied territories has consistently increased since 1986 and exceeded 800 beginning in 1990 when 861 territories were reported. The area has exceeded 800 for the last 10 years. The Pacific States Recovery Area held 1,480 pairs in 1998 (USDI 1999b).

There is no critical habitat designated for bald eagles and therefore this opinion will not examine critical habitat or effects on critical habitat.

12.5 Conservation Needs

12.5.1 Range-Wide

Each of the five regional bald eagle recovery plans set specific recovery goals for the regions. The recovery plans contain several numeric targets for numbers of breeding pairs in the region, productivity rates, and other criteria for delisting. The Service reviewed the status of bald eagles in 1999, and determined that most of the recovery criteria had been met or exceeded, and that bald eagles had, in general increased throughout each recovery region and bald eagle numbers had decreased in no sizable areas.

Some threats remain, including, but not limited to: contamination from toxins and lead associated with waterfowl hunting, habitat loss or impairment from increasing of human use in bald eagle habitat, incidence of disease, including new diseases for which causes or treatments are not understood, and injury from wind turbines. Long-term survival of bald eagles depends on the relationship of these threats to the reproductive rate and individual survival of eagles. Despite these and other threats, bald eagle numbers are generally increasing or stable, and as such, no additional specific conservation needs were identified in the Service’s 1999 proposed rule to delist bald eagles. The proposed rule, however, clearly indicates the stable or increasing trend for bald eagles was caused by existing and past conservation efforts to avoid or reduce known threats. A reduction in existing conservation efforts, then, would be expected to cause a reduction in the stable or increasing population trend.

In addition, literature indicates that survival of adult birds is very important to population maintenance. A population can have a maximized reproduction rate, but if survival of the breeding adults is low, extinction can still occur (Grier 1980). Stalmaster (1987) felt that due to the longevity of bald eagles, the importance of their reproduction rate was secondary to keeping individuals in the existing breeding population alive.

Along with maintaining low contaminant levels, one of the keys to both adult survival and successful reproduction is the quantity and quality of available food during winter(Stalmaster 1987; Stalmaster and Kaiser 1997; Swenson et al. 1986). Winter is the season that exerts the highest stress on eagles and can sap energy stores and body fat for thermo-regulation. Particularly during winter stress, without adequate food resources eagles may starve. Starvation occurs most commonly in young birds that are less efficient at foraging (Stalmaster and Gessaman 1984). Winter also immediately precedes the breeding season. Therefore eagles need to find enough food to ensure adequate physiological condition to initiate breeding. Breeding is often initiated in late winter when nightly temperatures may dip below freezing, so it is imperative that eagles survive winter in excellent physical condition to withstand the rigors of breeding. This relationship of winter food to eagle survival and reproduction is one of the main reasons that wintering populations were singled out in the Pacific States Bald Eagle Recovery Plan as needing protection and monitoring.

As previously described, wintering habitat requires a combination of available food and low disturbance, with appropriate roosting nearby. Protection of wintering areas requires protection of foraging and roosting habitat and assuring the two remain in relatively close proximity to one another.

12.5.2 Pacific Recovery Area

The Pacific States Bald Eagle Recovery Plan (USFWS 1986) established recovery population goals, habitat management goals, and 47 management zones (i.e., recovery zones). Reclamation's proposed project is located within this Recovery Area and the Klamath Basin Recovery Zone (22) that includes a portion of Northern California. The Pacific States Bald Eagle Recovery Plan (Recovery Plan) described these specific criteria for the Pacific Recovery Area (PRA) as necessary for delisting :

1. The PRA should have a minimum of 800 nesting pairs;
2. PRA pairs should produce an annual average of at least one fledged young per pair, with an average success rate per occupied territory not less than 65% over a 5-year period;
3. PRA population recovery goals must be met in at least 80% of the management zones (e.g., 38 out of 47 recovery zones); and
4. Wintering populations greater than 100 individuals should be stable or increasing.

Wintering areas and the eagles that use them are critically important to recovery and long- term maintenance of the species. The Recovery Plan states that before delisting "Wintering populations greater than 100 individuals should be stable or increasing" (USFWS 1986). The Service's 1999 proposed rule to delist bald eagles did not state that the wintering criteria had been met, but rather indicated that winter populations "...are difficult to assess because concentrations are dependent on weather and food supply and thus can be quite variable from year to year" (USDI 1999). The Pacific States Bale Eagle Recovery Plan is now seventeen years old, but the necessity of protecting wintering areas for bald eagle conservation is still widely held. For example, the Bald Eagle Working Group for Oregon and Washington (Working Group) expressed concern in response to the Service's proposal to delist bald eagles, stating "...stable or increasing wintering population has not been confirmed" (Leighty 1999). In the same letter, the Working Group stated that even state and federal laws might not be currently adequate to ensure protection for wintering populations and communal roost areas even on state and federal lands. Uncertainty remains that the Recovery Plan delisting criteria have been achieved, and Working Group's concerns for the stability of the wintering eagles in this recovery area underscores the importance of maintaining and protecting the wintering area and population in the Klamath Basin.

During the late fall and winter, as many as 1,100 bald eagles from throughout the Pacific Northwest, western states and Canada migrate into the Basin (McClelland 1994; Keister et al. 1987). Some evidence suggests immature and subadult eagles linger in or near Lower Klamath NWR for a few months after the bulk of the breeding eagles have dispersed to nesting areas. Lingering on wintering grounds, especially Lower Klamath NWR, represents an important opportunity for eagles to feed where food is plentiful and harassment from other eagles is low.

Given the large number of bald eagles wintering in the Lower Klamath NWR, maintenance of the wintering area for continuous occupation of large numbers of bald eagles should be considered part of the conservation needs of the bald eagle both in the Pacific Recovery Area and in North America.

13.0 ENVIRONMENTAL BASELINE

13.1 Status of the Species within the Action Area

This section addresses historic and recent past operations of the Klamath Project. In some years, up to 120 pairs nest and 1,100 individual bald eagles winter in the Klamath Basin. Since 1990, about 200-1,100 bald eagles wintered in the Klamath Basin. In 2001, the Klamath Basin Recovery Zone contained 120 occupied breeding sites, exceeding the Recovery Plan population goal of 80 for the zone (USFWS 1986). The Klamath Basin breeding population is approximately 30% of the nesting bald eagles in Oregon Recovery Zones and the small area of Washington included in the Columbia River Recovery Zone.

The 1986 Pacific States Bald Eagle Recovery Plan (Recovery Plan) designated 47 smaller zones to facilitate recovery and planning efforts. The Washington and Oregon zones (22 total) were addressed in the Working Implementation plan for bald eagle recovery in Oregon and Washington [WDW 1990 (Implementation Plan)]. The project area is within the Klamath Basin Zone of that planning document. In general, the Klamath Basin Zone overlaps lands in California and Oregon, including the upper basin watershed of the Klamath River, Sprague River, Goose Lake Basin, Clear Lake area and Modoc Plateau. General goals for the Klamath Basin Zone are outlined in the Implementation Plan.

Bald eagle populations in the Klamath Basin include 3 groups: breeding adult pairs, non-breeding immature and sub-adults, and wintering birds, including many migratory adults which breed hundreds of miles north and west of the Klamath Basin. Following is a brief discussion of the biology and status of each of these groups in the Basin.

13.1.1 <u>Adult Breeding Pairs</u>

One hundred-twenty nesting pairs occur in the Klamath Basin including on or near Upper Klamath Lake, Gerber Reservoir, J C Boyle Reservoir, the Klamath River, and the Lost River (Isaacs and Anthony 2001). Because bald eagles depend on water bodies for a food supply, most of these nests could be affected by Reclamation’s water deliveries to the Klamath Project. The Recovery Plan set as a goal; a five year average of 1.0 young per year per occupied site for breeding eagles. Over the past 5 years Oregon and Washington reproduction rates per occupied site have been 0.99 young per nest and 0.86 young per nest respectively (Isaacs and Anthony 2001). The Recovery Plan also set as a goal; a five year average success rate of 65 percent. The five year average success rates per occupied territory was 62% in Oregon and 56% in Washington (Isaacs and Anthony 2001). Neither of the Recovery Plan goals have been completely met.

Roughly half of the breeding pairs nest near Upper Klamath Lake. Four nesting pairs hold territories on or near Gerber Reservoir. The status of adult breeding pairs and their habitat on these two areas, and the potential nesting area on Clear Lake is discussed below. Many of the other nesting pairs use Gerber and Upper Klamath Lake or other parts of the action area affected by the proposed operations of the Klamath Project and effects on those nesting bald eagles would be similar, but less severe than those described for the Upper Klamath and Gerber Reservoir. Bald eagles do not have nesting territories in some portions of the action area, and those areas are not discussed in this section.

Upper Klamath Lake

Greater than 50 eagle nesting territories occur on or near Upper Klamath Lake. Eagle reproduction at Upper Klamath has been within the typical range (1.02 young per nest) for this recovery zone the past 5 years (Issacs and Anthony 2001). Many of Upper Klamath Lake nests occur on Forest Service lands near Upper Klamath Lake National Wildlife Refuge. The eagles nesting in these territories use the Recreation and Crystal Creek areas to forage for prey. Aerial photographs of this area show hardstem bullrush encroachment into many of the small channels and pools used by eagles (R. Hardy, pers. comm. 2001.) This also appears to be happening in the areas near Hank's Marsh near Highway 97 on the east side of the lake and near Eagle Ridge (R. Opp, pers. comm. 2001). While marshes generally exhibit high diversity due to the variety of microhabitats, bullrush expansion causes a loss of shallow, open water favored by eagles for foraging. The reduced foraging areas near nests and may push eagles into channels used more heavily by recreationists.

The reasons bullrush is increasing are not known. Bullrush expansion is naturally limited by water depth and generally dependent on seeds for propagation. The establishment of the Klamath Project and the manipulation of lake levels may have contributed to conditions favorable to expansion.

Enhancement and restoration of natural wetland habitats has occurred in Agency Ranch and the Wood River area and have made the upper Basin more attractive to waterfowl. This may have resulted in a slight increase in prey for eagles nesting near those areas during the spring and summer. In late fall and winter as ice covers the Agency Ranch and Wood River wetlands the waterfowl move lower in the Klamath Basin to open water.

Two known nesting territories occurred at Gerber Reservoir in the 1992 and were noted in subsequent biological opinions on Reclamation operations. Since then, two additional territories have been established in the area of Gerber Reservoir (Isaacs and Anthony 2001; G. Sitter, pers. comm. 2001). The increase in nesting at Gerber Reservoir is likely the result of increasing number of eagle pairs in the basin, 6 years of high reservoir levels and possibly "packing" of available habitat.

Since the addition of two nests, the reproductive rate of all four nesting territories has been considerably lower (Issacs and Anthony 2001) than the rate of 1.0 young per occupied site per year Recovery Plan criteria. From 1986 through 1989, the Gerber nests averaged 1.25 young per year. From 1990 through 2000 the nests averaged approximately 0.43 young per nest. The nests were monitored in 1991 because of concerns over effects of the low reservoir levels and the Service considered a supplemental feeding program. No young were produced in 1992 and no supplemental feeding program was implemented. Successful eagle reproduction at Gerber Reservoir might be influenced by competition for a shrinking forage resource if Reservoir levels were lowered (BLM 1992).

Clear Lake

No known bald eagle breeding territories occur around Clear Lake. Currently, eagle use is limited to foraging by eagles that nest in nearby areas and migrating birds, especially in dry years. With the expanding population of eagles in the Klamath Basin and limited foraging territories, it is possible that eagles may attempt to establish a foraging territory near Clear Lake.

Breeding Season Use of the Klamath Basin by Non-breeding Adult and Immature Bald Eagles

The Klamath Basin provides summer and winter habitat for nonbreeding adult and immature eagles from local populations and from outside the Basin and other recovery zones. Wintering is discussed below (section 2.13). The number of non-breeding adults and immature bald eagles that use the Klamath Basin in the summer is unknown. Due to the dominance of territorial mated pairs, non-breeding adults and immature eagles are likely to have limited opportunities for using prime foraging areas in the Klamath Basin.

Wintering Eagle Status in the Klamath Basin

The Klamath Basin harbors one of the largest winter concentration of bald eagles in the lower 48 states and regularly supports 500 to 1,100 birds. In most winters 80 to 90 percent of the eagles in the Basin forage on Lower Klamath NWR (Klamath Basin NWR, 2001). The highest recorded number of bald eagles wintering on Lower Klamath NWR is 950. Eagles that winter in the Basin nest in Canada, Oregon, Washington, California, and Arizona (Frenzel, 1985; Watson and Pierce 2001). Mid-winter eagle counts have shown approximately 40% of all California eagles winter on Tule Lake and Lower Klamath NWR (Detrich 1986).

As discussed above, waterfowl are the main food source of wintering bald eagles in the action area. Table 13.1.1-1 shows recent habitat used by waterfowl prey areas and water use required to maintain those habitats on the Lower Klamath NWR. The current trend in the predictability, abundance, and availability of waterfowl that the wintering eagles in the Basin depend cannot be described as stable.

Table 13.1.1-1. Habitats important to waterfowl and bald eagles on Lower Klamath NWR in 1992, 1994, and a year of full water delivery (planned for 2002).

Year	Permanent wetland Acres	Seasonal wetland[1] Acres	Acres of Small grains[2]	Total wetland Acres	Acre-feet of Water need/use[3]	Peak fall waterfowl	January waterfowl	January eagles
2002 Habitat Plan[4]	Approx. 11,000	Approx. 8,000	Approx. 5,000	Approx. 19,000	Approx. 69,000	up to 1.8 M	up to 340K	up to 958
1992	5,005	6,258	3,986	11,263	43,930	804K	3,750	51
1994	9,104	4,955	3,648	14,059	50,974	607K	166,000	465

[1] Flooded prior to October 31. Other wetlands would flood after this date.
[2] Flooded December, January, and February.
[3] Water need/use May-October for permanent and seasonal wetlands and Dec-Feb. for winter irrigation of grain.
[4] Water management planning assuming full water delivery to Lower Klamath NWR sufficient to meet the refuge's legislated purposes for a full range of endemic species.

Eagles from northern areas winter in the Klamath Basin because of concentrated food sources and nearby roosting habitats. Eagles from the south come north to capitalize on the same resources. Data suggest that degraded weather and prey conditions in other regions may cause eagles to move into the Basin to feed on waterfowl and rodents. The combination of abundant food and roosting habitat is so unusual and important that its protection was cited as the reason the Bear Valley National Wildlife Refuge was established in 1978. Bear Valley NWR is one of the few refuges or sanctuaries of its kind in the United States.

Large winter concentrations of eagles in the Klamath Basin have been noted as early as the 1930's when up to 200 eagles gathered just at Tule Lake to feed on waterfowl (Worcester 1934 *in* Weddell et al. 1998). Bald eagles have likely been congregating in the Basin to winter for hundreds of years to feed on waterfowl as millions of ducks and geese migrate through this narrow point of the Pacific Flyway. Telemetry data suggests that like waterfowl, eagles follow traditional migration paths when dispersing from breeding areas to wintering areas (Hunt et al. 1992). Although some of these natural paths may be similar to flyways for waterfowl, the eagles are not necessarily following waterfowl. The large number and concentration of eagles found the Klamath Basin clearly indicate the area is a rich source of food with adequate winter roosts, and the eagles depend on it as a wintering area. This dependence may have increased with the recent loss of the large salmon runs that eagles depended on in the past (Bennetts and McClelland 1997).

Before the establishment of the Klamath Project wintering waterfowl were spread out over a larger portion of the Basin and were much less restricted in their choice of feeding and loafing areas. The Klamath Project significantly reduced the Basin's wetlands by draining and "reclaiming" them. Through these actions an estimated 70% of the Basin's wetlands were lost. This resulted in most of the potential waterfowl habitat, especially habitat available during freezing conditions, to be concentrated on the Tule Lake and Lower Klamath NWRs. Project operations also make those areas completely dependent on Reclamation's management of Upper

Klamath Lake levels and water deliveries to irrigation districts for water to manage the remaining wetlands.

Reclamation's irrigation deliveries throughout the Project area eventually reach Lower Klamath and Tule Lake after use as irrigation on agricultural lands. Reclamation also allows some direct water deliveries from Upper Klamath Lake and the Klamath River to the Refuges. These deliveries in turn provide water to flood wetlands, stubble fields and deep water areas on the Refuge. This habitat then becomes a resting and feeding area for millions of southward migrating waterfowl passing through this portion of the Pacific Flyway. When water is available during the growing season to allow development of seasonal wetlands and flooded grain fields, hundreds of thousands of the migrating waterfowl stay through the winter and provide food for wintering eagles. Later in the winter, water is used to flood agricultural land on Refuge lease lands and neighboring private lands (Klamath Drainage District). This late winter flooding creates diverse and changing habitats that attract swans, geese and early duck migrants coming north to breed. Waterfowl stop to rest and stage for continued northward migration. In years that this northward migration occurs in February, the Northbound arrivals increase the numbers of dwindling overwintering waterfowl and bolster the food source for eagles. The late winter flooding also pushes small mammals to the surface where they provide an additional source of prey for wintering eagles as waterfowl numbers may be declining.

A major component to the eagle's efficient exploitation of abundant food resources in the Klamath Basin is available roosting areas. Keister (1983) identified five main winter roosts that supported the large number of wintering birds in Klamath Basin. The largest roosting area, Bear Valley NWR, is near Worden, Oregon. The Mount Dome roost is six miles south of Lower Klamath in California. The Three Sisters roost is six miles south of Mt. Dome in California. The Caldwell roost is 11 miles south of Tule Lake and the Cougar roost is one mile south of the Caldwell roost in Lava Beds National Monument, California. The Bear Valley roost has been occupied by as many as 400 eagles (Dellasala et al. 1998). Historically these roosts were used in conjunction with 3 main feeding areas; Lower Klamath NWR, Tule Lake NWR and private lands of the Klamath Drainage District adjacent to the refuges. The roost areas are all close to those feeding areas and the eagles shift roost preferences to save energy in flight time as prey location shifts.

The primary prey base for wintering eagles in the Klamath Basin is waterfowl. The species most often consumed are mallards, pintails and wigeon. Waterfowl that are injured during the hunting season are a significant source of easy prey for the eagles. Also, waterfowl that are stricken with avian cholera are easily captured or scavenged (Frenzel 1985). Small mammals that leave flooded burrows become important as agricultural lands are flood irrigated in late winter (Frenzel 1985 in Keister 1987). All of these factors; water management, number and distribution of waterfowl, and weather determine the size and availability of food for wintering eagles during the stressful winter season.

Traditionally all three feeding areas (Lower Klamath, Tule Lake and Klamath Drainage District lands) were used each year by wintering bald eagles (Keister, 1987). Since 1984, data shows a steady and prominent decline in eagle foraging on Tule Lake (Klamath Basin NWR 1997) that is strongly correlated with a decline in waterfowl use. This decline and a possible cause are noted in Reclamation's draft 2001, BA "...the decline in waterfowl numbers appears to be related to the loss of extensive areas of emergent wetlands." (USBR 2001). Other factors include: siltation of deepwater habitats (approximately ½ inch of water column lost each year since 1959 (USBR 1987); insufficient water to produce seasonal marshes in the fall; and stabilized water levels on Tule Lake that reduce the aquatic productivity for waterfowl foraging. In addition, the Kuchel Act of 1964, (an Act which specifies agricultural management on the refuge) was initially interpreted as restricting wetlands to the present Sumps and sought to maintain water levels with little fluctuation. It became apparent by the early 1990's that the result of that management was degraded wetland habitat conditions reducing waterfowl and eagle abundance. Experimentation of alternate management for Tule Lake has resulted in significant use by both waterfowl and eagles.

Factors such as static water levels in the sumps, have been influencing conditions at Tule Lake since the 1960's. Limited or unpredictable water deliveries are more recent management problems. The more recent, observable decline in waterfowl and eagle use, coming some years after the onset of siltation and habitat changes, may be the result of a lag in changes of traditional behavior patterns. Waterfowl, as with most wildlife, often continue to follow migrational behavior patterns even when those behaviors are not as beneficial as they once might have been. This can result in behavior changes being observed several years after adverse habitat changes. Whatever the exact mechanism, the long- term decline in waterfowl and eagle use of Tule Lake is well documented.

Secondary impacts in the reduced quantity and quality of habitat on Tule Lake have been a shift in waterfowl use to Lower Klamath in both the fall and winter. This has been accompanied by a steady increase in the concentration of eagles on Lower Klamath NWR. In the last 6-8 years less than 10% of the eagles in the Basin are counted on Tule Lake (Klamath Basin NWR 1997). The data shows clearly that Tule Lake has largely lost it's historical role as one of the primary feeding areas for wintering eagles. As a result, the number of traditional feeding areas for the very large concentration of eagles has been reduced from three to two.

An indication that this trend could be reversed given time and water is seen in the results from research at Tule Lake. A recent study by the University of Washington on seasonal draw downs of water found that carefully timed draw downs effectively promoted wetland plant diversity (Washburn 2001). An example of this was observed in 2001 on Tule Lake NWR.

In 2001 the Sump 1B portion of Tule Lake was de-watered in May and June to promote germination of moist soil food plants for waterfowl and emergent vegetation such as cattail and hardstem bulrush. The area began reflooding in late August with return flows from the Copic Bay area. In September return flows from the 70,000 acre-feet released from Upper Klamath Lake were also delivered to Tule Lake. Reclamation and TID directed this water be held in Tule Lake as potential reserve rather than send it to Lower Klamath. This resulted in the creation of valuable waterfowl habitat. Winter waterfowl use of Tule Lake peaked at 248,000 birds, an increase of 62 percent over the previous year. Peak eagle use also increased from 10 to 21 in 2001-2 (Klamath Basin NWR 2002a).

These observations and results from research on the refuge demonstrate the capacity of eagles to shift locally to restored feeding areas. This type of restoration or enhancement is consistent with the Recovery Plan (USFWS 1986). The Plan lists it as a specific task in its step-down narrative:

> "1.3122 Enhance Waterfowl Habitat On Bald Eagle Wintering Areas.
>
> Because of their importance both as a primary and secondary eagle food source, waterfowl populations should be encouraged to use areas of open water where bald eagles winter. A small population of waterfowl can support many wintering eagles. Waterfowl habitat management can include water level management and establishment of food plants , such as unharvested corn."

Cooperative lands and lease lands on Lower Klamath and the private lands of the Klamath Drainage District (KDD) adjacent to the refuge also provide another food resource for the wintering eagles. These lands are flooded in later winter to raise soil moisture and control rodents. As the fields are inundated with water thousands of rodents are forced to the surface and are easy prey for eagles and other raptors (Keister et al. 1987). This results in an important food source later in the winter when waterfowl numbers normally are declining. However, just like Tule Lake and Lower Klamath NWR the KDD lands rely on Reclamation for water to flood irrigate. The private lands also are under no requirement to flood fields. In recent years with the possibility of growing season water shortages the private land owners tendency has been to flood their lands earlier to utilize water before water shortages arise (D. Mauser, pers. comm. 2001). Earlier flooding (during November- December) of these fields still increases rodent-prey availability, but then does not coincide with the January and February waterfowl shortages when eagles would benefit from an alternate food source.

The benefits of flooded fields, specifically in the Klamath Basin, was discussed in the Recovery Plan. The stepdown narrative outlined tasks to implement for recovery:

> "1.3124 Encourage Flooding Of Fields Where Appropriate, To Make Rodents Available To Eagles
>
> Flooding of agricultural fields for the purpose of rodent control provides an important food source for wintering eagles in the Klamath Basin. As many as 4,400 bald eagle use-days were recorded on one ranch in December 1981. Many farmers use flooding as an alternative to poisoning and thereby do not contaminate potential eagle food sources." (USFWS 1986)

Since flooding on private KDD lands depends on water availability and the willingness of private landowners to do so, Lower Klamath NWR should be considered as the only feeding area currently protected and (with adequate water delivery) a reliable feeding area for wintering eagles. The significance of the LKNWR is demonstrated by data from the last five years that show the area supports greater than 50% of all the wintering eagles found in the Basin, and harbors closer to 80-90% in most years.

However, Lower Klamath NWR is dependent on Reclamation for water delivery. In recent years with the change in lake levels, drier water years and concern for the needs of downstream resources, consistent, predictable and adequate water delivery for Lower Klamath NWR is uncertain. In four different years between 1992 and 2001 the Refuge has had their water supplies shut off or reduced (D. Mauser, pers. comm. 2001).

Studies have shown that eagles move out of dispersed wintering areas when food becomes scarce (Swenson et al. 1986, Isaacs et al. 1996). Numbers of eagles using the Basin may fluctuate higher as a result of regional food scarcity driving eagles into the Basin in low food years. This behavior tendency and the geographic position of the Basin, suggest that in times of general food, weather or drought stress, in region rely on the Basin as a “safety net” during periodic, but widespread, declines of available food.

Drought conditions may be a factor in these shifting patterns. In January of 1992 the number of eagles in the basin reached a recorded high of 1,151 birds. 1992 and 1994 were also a years of peak eagle numbers at a wintering site on John Day River about 250 miles to the northeast (Isaacs et al. 1996). These and other observations coming on the heels of a several year drought cycle suggest that regional droughts push eagles out of marginal areas to areas of greater prey abundance. Drought years are also those when Reclamation water deliveries to the refuge will be most at risk because needs of primary water users are given higher priority. Therefore a combination of harsh years, reduced water deliveries, high numbers of wintering eagles and low or non-existent waterfowl populations would result in very high levels of adverse impacts to local and wintering eagles. This underscores the importance of maintaining and managing for the stability of the wintering eagle population in the Klamath Basin.

As recently as September of 2000, due to water shortages, Reclamation stopped delivery of water to the Refuge. This threatened the availability of water for fall waterfowl habitat and reduced the numbers of waterfowl that would use the refuge. Refuge managers and agency executives considered the possibility of closing the refuge to waterfowl hunters. The hunting closure was averted when a thunderstorm system brought additional water to Upper Klamath Lake, and water was released into the system from Clear Lake.

13.2 Other Factors

A number of factors are known to impact bald eagles. They can be generally categorized as: (1) presence, abundance and seasonality of food resources; (2) winter roosts; (3) nest sites; (4) harassment and disturbance; and (5) poisons and contaminants. The most significant factors in the Klamath Basin are probably nest sites, winter roosts and food resources. The sections below generally discuss these factors. The specific relationships between these factors, the status of the bald eagle in the Klamath Basin, and the proposed project will be discussed in the “Effects of the Action” section of this opinion.

13.2.1 <u>Food</u>

The bald eagle is a bird driven by the availability of food and has food habits that are very diverse (Stalmaster 1987). Given the availability of prey the most restrictive element in successful feeding is presence of large expanses of hunting areas (open water or land) that are undisturbed (Stalmaster 1987). Bald eagles pirate food from Ospreys, catch fish, small mammals and birds, and scavenge from waterfowl die-offs and deer killed by vehicles. Eagles prefer fish especially during nesting if fish are available (Kaufman 1996).

In the Klamath Basin there are three major classes of prey which vary by season: (1) fish, breeding waterfowl, and small mammals available during the eagle breeding season; (2) concentrations of migratory waterfowl available to eagles during the fall and winter months; and (3) small mammals made available due to irrigation flooding during late winter months. Each of these forage classes is influenced by water management and irrigation practices.

Prey becomes available to bald eagles in two ways: (1) when the behavior of a live individual prey item makes it available for capture, such as a fish basking or feeding near the water surface; or (2) when the carcass of a dead individual is available on the ground, on ice, in shallow water, or floating at the water surface. In general, only a portion of dead prey is actually discovered and taken before it becomes unavailable through decomposition or is taken by other scavengers. The number of dead prey items is a function of the live prey population size, in that the larger the live population the more likely it is to have dead or dying members from injury or disease outbreaks.

At Upper Klamath Lake, important prey species during the nesting season include tui chub, blue chub and suckers (Frenzel 1985). Territorial nesting bald eagles in the Klamath Basin remain on or near their territories year round but do (particularly in cold early winters) benefit immensely from the winter feeding areas on Tule Lake and Lower Klamath. Recent restoration efforts on and near Agency Lake should contribute to higher numbers of nesting and loafing waterfowl until fall. These waterfowl provide some additional food for nesting adults and fledglings. In winter waterfowl abandon these areas and congregate on Tule lake and Lower Klamath.

Species composition of eagle prey at Gerber Reservoir has not been documented. The reservoir's fishery resource consists largely of introduced species such as crappie, perch, bass, and also includes rainbow trout and native suckers.

In the late fall and winter, resident territorial pairs and non resident eagles migrating to the area feed on the waterfowl streaming through this area of the Pacific flyway. Waterfowl are an excellent food source for eagles. It digests well because of its fat content and delivers more calories per gram than other foods. Fish are a much less efficient food source (Stalmaster 1987).

Waterfowl become food for eagles through several circumstances. Live and healthy ducks and geese can be pursued and killed by eagles but the success of this technique limited (Griffin 1982; McWilliams et al. 1994). Waterfowl that are crippled or die as a result of hunting, but are not recovered by hunters, are a much easier source of food for eagles. Waterfowl also have outbreaks of diseases such as avian cholera when massed in large numbers over small areas. Waterfowl weakened or killed by cholera are readily captured or scavenged by eagles (Griffin 1982). Weakened or compromised waterfowl that are more easily caught are an especially important food source for young eagles with limited foraging experience. These eagles are able to hone foraging skills by practice and by observing older more proficient birds. The importance of easy prey for young eagles may be the reason that young eagles tend to arrive first and leave last in food rich winter feeding areas (Griffin 1982; Zwank 1996). Young eagles have been found to be proportionately less common at low yielding feeding sites (Stalmaster and Kaiser 1997). A ready food source, available in the winter when foraging success is low and energy demand is high, is crucial to winter survival for eagles. Without an adequate food source eagles can die from starvation or hypothermia (Sherrod et al. 1976 in Stalmaster and Gessaman 1984).

In the Klamath Basin another important source of food in the late winter is small mammals. Agricultural fields are often flooded in late winter to reduce destructive crop pests living in the soil and to raise soil moisture before the growing season. The gradual flooding of large fields forces small mammals out of burrows and makes them susceptible to waiting eagles and other raptors (Keister et al. 1987; Frenzel 1985). The flooding can also attract and hold early arriving swans and ducks on their migration path north.

The bald eagle is considered to be a species that is limited by food supply (Griffin 1982; Stalmaster and Gessaman 1984). Food resources may be the most important resource influencing the life and evolution of the bald eagle (Stalmaster 1987). This factor in eagle management and its relationship to the conservation of wintering populations has not received the attention it deserves (Stalmaster and Gessaman 1984; McClelland et al. 1994). Food availability has been cited as regulating the eagle population on Amchitka Island, Alaska where as many as 90% of all eagles die of starvation before reaching adulthood (Sherrod et al. in Stalmaster and Gessaman 1984).

Food availability and abundance are what have produced several large wintering groups of bald eagles. Most of these wintering groups are made up of hundreds of eagles (Stalmaster 1987). All large winter congregation sites have in common an abundance of food, little human disturbance and roosting areas. The food is most commonly fish or waterfowl. Large congregations of eagles enhance individual survival by making food resources easier to locate and reducing search time. (Stalmaster and Gessaman 1984; Knight and Knight 1983). Once eagle migration to wintering areas is complete, eagle numbers on wintering areas appear to have a strong correlative relationship with the amount of food available (Griffin 1982; Keister et al.1987; Mauser and Thomson 2001).

Food availability is also affected by the amount of disturbance to feeding eagles. Foraging areas need minimal disturbance from human activities (Stalmaster 1987; Stalmaster and Kaiser 1998). Eagles are large and not as adept as many birds at becoming airborne which may be one reason eagles tend to select areas to feed that give them a large sight distance to watch for disturbance or predators. Areas that may have large amounts of food but lack the open areas necessary for security to feeding eagles are likely to receive little use (Stalmaster 1987).

The success of eagles and raptors in finding sufficient food in winter, storing body fat and maintaining good physiological condition is likely to translate into greater reproductive success (Newton 1979 in Stalmaster 1987). There is good evidence that the number of eagles at wintering areas (like the Basin) are responding to poorer conditions elsewhere (Dunwiddie and Kuntz 2001; Watson and Pierce 2001). Since eagles move among potential or historical feeding areas in winter and many of the eagles wintering in the Basin are from other areas, poor feeding conditions in the basin put birds throughout the western U.S. at a reproductive disadvantage when they return to their nesting territories.

Changes in behavior as a result of food scarcity or loss

The literature and recorded observations are consistent in their conclusions about changes in bald eagle behavior in response to changes in food amount, availability and quality.

Changes in the availability of food result in several behavioral responses because eagles tend to use the same feeding areas from year to year. For example, even years after fall food supplies disappeared in Glacier National Park, eagles identified from patagial tags were seen moving through the area on their way to wintering areas in Idaho, Montana and Utah (McClelland 1994). Glacier National Park was an autumn migratory stop not a winter destination. Similarly, use of wintering areas by eagles also seems to be traditional in that it follows patterns learned in the past (Isaacs et al. 1996). Many studies on repeated wintering use and eagle behavior indicate eagles will continue to migrate to areas that supported food in the past. Eagles that arrive and find diminished or non-existent food sources have to forage a much wider area to locate smaller or short-term food supplies, and some may remain in the area and suffer lowered fitness. Often, immature eagles are greater in number than adults at wintering areas and because immature bald eagles are inexperienced and less successful at foraging (Knight and Knight 1983), they would be more likely to suffer stress, lowered fitness and mortality than adult eagles.

The need for eagles to range wider in search of prey during shortages at traditionally steady food supplies was demonstrated by radio telemetry data on wintering bald eagles in Missouri. Foraging eagles were fitted with transmitters and followed during different years. The data showed that when waterfowl concentrations were low, eagles ranged more widely and spent more time searching for prey (Griffin and Baskett 1985). In fact for the year 1976 the average size of a foraging eagle range was 2.6 times greater than 1978, a year when waterfowl were abundant.

In the Basin, when waterfowl numbers are reduced or eliminated by natural or man made causes, eagles are forced to search for other food such as dead ranch animals, road killed mammals and hunter wounded deer and elk. Any of these potential sources are less concentrated than waterfowl. and increase exposure of eagles to harassment or danger. This is supported by observations in the Basin. The winter of 1992-1993 was a cold winter and in January of 1993 waterfowl numbers on Lower Klamath dropped to 3,750 largely due to ice cover and eagle numbers dropped to 51 on Lower Klamath. At a small wintering area on the John Day River in Oregon, bald eagle numbers dropped also (Isaacs et al. 1996). Researchers attributed it to a reduction in prey availability due to ice and snow cover on the landscape (Isaacs et al. 1996) . The same year, Klamath Basin NWR personnel received reports of many eagles feeding on roadkills and in areas nearer to humans (J. Hainline and D. Mauser, pers. comm. 2001). These behaviors and movements by stressed eagles increase the risk of death from injury (road kills, power lines, indiscriminate shooting) and exposure and also risks the fitness of eagles returning to other areas to breed. These observations demonstrate the relationship between foraging patterns in the basin during low prey availability and are similar to those recorded elsewhere.

Another example of a behavior shift occurred along the Colorado River corridor. A study by Riper et al. (1995) collected data on a recent bald eagle wintering population feeding on spawning trout. Observations showed a closely parallel trend between number of spawning trout and numbers of wintering eagles from 1989 to 1994. During 1992-1994 numbers of wintering eagles was low. In 1994, Riper et al. (1995) "received numerous reports from state and federal agency biologists of small eagle concentrations at elk and deer carcasses over the southern Colorado Plateau." Brown (1993) also observed shifts in areas that were foraged even within river habitats. When prey density in the shallow edge of the Colorado River dropped, eagles spent more foraging effort in the deeper parts of the river and had a lower success rate. These studies clearly demonstrate that as prey abundance drops eagles forage more widely and are less successful. These shifts in behavior due to less plentiful food result in greater adverse effects which can reach the level of injury or death.

Farther north, in Alaska, where conditions are more severe, large numbers of young birds perish of starvation before reaching adulthood (Sherrod et al. in Stalmaster and Gessaman 1984). This information in addition to the telemetry data in Missouri (Griffin and Baskett 1985) suggest that eagles do not readily leave traditional concentrated food sources even when faced with reduced or absent prey. Since availability of prey is correlated closely with eagle numbers it is likely that most food concentration areas are saturated already (Hunt et al. 1992) or are not suitable.

In the Central Valley of California, waterfowl winter in very large numbers and the conditions in that area lead to thousands of ducks dying from cholera. However bald eagles have not used this large food source to any significant degree. In fact, the presence of more than a few transient eagles in that area is unusual (D. Mauser, pers. comm. 2001). In 2000, the midwinter count from refuges near Sacramento, California showed 28 eagles, and that was higher than usual (J. Silveira, pers. comm. 2001). A study from 1985-1987 on eagle interactions with cackling geese in four California valleys showed less than 10 eagles in the Sacramento Valley, San Joaquin Valley and Big Valley study areas. By contrast the Klamath Basin study area had between 109 and 965 eagles in those years (McWilliams et al. 1994). Data collected from winter bald eagle counts since 1987 does show consistent presence of eagles in specific areas of Northern California. Some of these areas are Bear Valley, Butte Valley, Cache Creek, Clear Lake, Claire Engle Lake, Eagle Lake, Lake Almanor, Lake Britton, Shasta Lake, and Modoc NWR. Most of these sites average fewer than 30 eagles, but Eagle Lake, Shasta Lake, Clair Engle have had more than 50 birds. Eagle Lake's bald eagle count has been increasing substantially in the last decade and has averaged 175 birds over the last 4 years. The Klamath Basin over the same period averaged 207. These counts are conducted before the number of eagles reaches its peak in the Basin. In ten of the last 14 years, Klamath Basin has had the highest wintering eagle counts, demonstrating the relative importance of the Klamath Basin.

The reason the Central Valley is not used by many eagles is not known. One possible reason is that the Central Valley lacks a climate that a supports the formation of partial lake ice. We do not know that partial lake ice is essential, but partial lake ice does form in Lower Klamath and provides advantages of a feeding platform, concentration of waterfowl into smaller areas, and an edge toward which carcasses drift. Ice also reduces competition from other mammalian scavengers. In short, ice provides a unique and shifting habitat that provides food and security. Another possible reason is the lack of coniferous roost trees. While plenty of deciduous roost trees occur in the Central Valley and are used as roosts, conifers are used as roosts in the Klamath Basin, and may be preferred by bald eagles.

Artificial feeding to reduce effects of food scarcity

Because survival of adult bald eagles is the cornerstone of population stability, artificial feeding has been proposed as a temporary solution to compensate for reduced prey levels in the action area (USFWS 1992, Stalmaster 1987; Marr et. al. 1995). However, artificial feeding contains some observed indirect effects and probable risks.

McCollough et.al. 1994 initiated a large supplemental feeding program along the coast of Maine from 1981 - 1985. The feeding program did affect the distribution of wintering eagles in the immediate area and use of the feeding sites increased over the study period. Those findings are consistent with other supplemental feeding studies by Knight and Anderson 1990 and Helander 1982. The feeding areas in Maine were also used heavily by corvids which facilitated discovery by eagles (especially young eagles) but also resulted in some “loss” of food to non-target species. In Maine the food type (mammal carcasses) was used specifically to reduce the availability of the food to gulls. Mammal carcasses were preferred and fish were avoided because of concern that gulls would significantly reduce the amount of supplemental food for eagles even though fish might have been easier to obtain. This was effective since frozen mammal carcasses are more difficult for gulls to open than are fish (C. Todd pers. comm. 2001).

Artificial feeding tends to further concentrate birds, habituate them to humans and leave them even more vulnerable to disturbance and injury. It can also introduce birds to food sources not normally used and can change behavior by conditioning them to unnatural foods. Artificial feeding also raises the number of gulls, crows, ravens and coyotes present at the feeding site (McCollough et.al. 1994; Knight and Anderson 1990). In spring, this increased number of scavengers and predators would create a substantial risk to nesting birds near winter feeding sites. For these reasons if artificial feeding is considered at all it should be as an emergency last resort, be short term in nature and should try to mimic, as closely as possible, natural foods and presentation. A situation which would call for artificial feeding would by definition be one in which birds are already stressed, and unlikely to be able to move to other food sources. Once feeding was initiated it would have to be continued until the crisis is over.

Since 2001, the Service has continued its review of studies on artificial feeding, discussed the issue with managers and researchers with experience in artificial or supplemental feeding, and explored the availability and adequacy of supplemental food sources and delivery techniques. The Service has concluded that artificial or supplemental feeding in the Klamath Basin is not a recommended alternative to maintenance and enhancement of waterfowl habitat which would produce a more stable and natural food supply for wintering eagles.

One of the reasonable and prudent measures included in the Service’s 2001 BO (USFWS 2001) to reduce take of bald eagles was an artificial feeding program. This program was to be used when Reclamation was unable to deliver adequate water to Lower Klamath NWR.

Reclamation's 2002 proposed action includes delivery of water to Lower Klamath NWR and therefore a significant impairment of feeding opportunities for eagles is not anticipated.

13.2.2 Roosts

Even though the primary reason eagles concentrate in areas during winter is food abundance, the birds also require appropriate roost areas near the food sources (Keister et al. 1987; Stalmaster and Gessaman 1984; Stohlgren 1993). These provide important protection from harsh weather and low temperatures and may also allow for social learning of food sources between birds within the roost (Knight and Knight 1983). Roosts located in coniferous forests provide shelter in the winter that is unavailable in deciduous trees that have lost foliage. In the winter, eagles will fly past lesser roost areas to reach roosts that offer the microclimate characteristics necessary to conserve critical body energy (Stalmaster and Gessaman 1984). These characteristics are usually found in late seral or old growth forests that have large trees for perching and foliage shelter (Stohlgren 1993; Keister et al. 1987; Isaacs et al. 1996). The Basin provides several large roosting areas that have those characteristics, are near to the winter feeding areas on the Klamath Basin Refuges and are relatively undisturbed. The Klamath Basin is one of only a few places in the region where that unique combination is available (Stohlgren 1993; Keister et al. 1987).

13.2.3 Nests

In the Basin, bald eagles nest in large douglas fir and ponderosa pines usually very near rivers, lakes or reservoirs. Nests are used year after year as long as the nest tree remains stable. Eagles have been known to use the same nest for decades.

Nesting success, as measured by number of young fledged, is tied closely to food availability. In the winter bald eagles must obtain enough food to come into breeding season in good enough condition to commence nesting activities in early spring. There must be adequate food near the nesting territory to support 5 weeks of incubation, and provide food for nestlings and fledglings for about 4 months. Lack of food at various points in the breeding cycle may inhibit nesting attempts, cause abandonment of the nesting effort, or result in starvation of young.

Reproductive rates are also subject to several secondary variables. In some areas of their range weather is an important factor. Because bald eagles have evolved in and adapted to the climate of the Pacific Northwest, weather is not thought to normally be a factor in reproductive failure. Serious storms that occur at the time of incubation or hatching create an exception. Low productivity in the Klamath Basin in 1982 was believed to be the result of such storms (Frenzel 1985).

Contaminants can influence reproductive success. While several persistent contaminants have been documented in eagle body tissue in the project area, Frenzel (1985) concluded that contaminant levels had no significant effect on the area's bald eagle reproduction at that time.

Human disturbance is an important factor affecting nesting success at certain sites (See example in harassment and disturbance section below), but is not believed to be pervasive in the project area. None of these factors appear to impose serious limits on eagle populations at the present time. In the absence of the above secondary effects, prey availability is believed to be the primary limiting factor for nesting success of these eagle populations.

The Klamath Basin contains approximately 30% of the nesting bald eagles in the Oregon, Washington portion of the Columbia River Recovery Area. (Isaacs and Anthony 2002). The Klamath Basin has been a significant contributor to the recovery of the eagle population in the Pacific Recovery Region. The past and future success of these nesting pairs and their young rely heavily on the Klamath Basin as a wintering area.

13.2.5 Harassment and Disturbance

Bald eagles can be very sensitive to human disturbance (Stalmaster 1998). Depending on time of year the impacts of human disturbance can be more or less serious. Disturbance particularly during nest establishment and incubation of eggs can result in abandonment of nests or death of nestlings. Recent data from the Winema National Forest showed a doubling of fledging rate for eagle territories in a management area after it was closed to vehicular travel (Hardy 1998).

Foraging eagles often hunt the shallow areas of lake shores and riparian areas which are also extensively used by fisherman and recreationists. The multiple demands on these areas can reduce the opportunity for eagles to forage and loaf. Stalmaster (1998) found that eagles feeding along the Skagit River reduced feeding by as much as 35% below predicted levels due to recreational boating and hiking.

Disturbance or flushing by eagles feeding in the winter can have a particularly negative effect on eagles by greatly increasing the energy needs during an already stressful period of time. Eagles seem to prefer roosting in undisturbed timber stands and feed in open areas, often on ice, that are some distance from possible sources of disturbance (Stalmaster 1998).

13.2.5 Poisons and Contaminants

Contaminants in the environment have had a significant impact on bald eagles. Among the reasons the eagle was listed as endangered in 1978 (threatened in Oregon) were very low reproduction rates and declining survival of adults. The leading cause for the low reproduction rate proved to be thinning of eggshells. Thinned eggshells were not able to support the normal pressure of incubating adults, resulting in broken eggs. The eggshell thinning was caused by high levels of DDE (dichlorodiphenyldichloroethylene) in the egg shells. DDE is a metabolite of DDT, an organochlorine pesticide in common use until 1972 (Frenzel 1985). This contaminant is bio-magnified in top predators and scavengers by their feeding on large numbers of contaminated prey items. Biomagnification of DDT in eagles has been as high as 4-fold in 120 days (Stickel et al. 1966; Chura and Stewart in Frenzel 1985).

Other poisons have caused, both intentionally and unintentionally, the deaths of golden and bald eagles. The compound 1080 (sodium fluoroacetate) and strychnine, both used to reduce populations of coyotes and other mammals, often had deadly consequences for non-target species including eagles (Terres 1982). Carbofuran, highly toxic, anti-cholinesterase insecticide was also responsible for some raptor deaths through secondarily toxicity. Intentional misuse of the insecticide has been linked to eagle deaths (Terres 1982) and it is now banned for use in its granular form. Several other anti cholinesterase pesticides have been implicated in eagles deaths (Environment Canada 2000) and are now either banned or under restrictive use to minimize potential effects on these and other non target species.

In the Basin, Frenzel conducted a study which evaluated the level of contaminants in eagle prey, eggs blood samples and body tissue. He found that wintering eagles did not have levels of DDT or DDE high enough to be associated with reproductive difficulties. Resident nesting bald eagles did exhibit moderate levels of DDE, PCB (Polychlorinatedbiphenyls) that suggested a reduced reproductive function (Frenzel 1985).

14.0 EFFECTS OF THE ACTION

14.1 Introduction

The effects section for Bald Eagles in Reclamation's 2002 BA (USBR 2002b) is reproduced below in its entirety.

> *"5.4 Effects on Bald Eagles*
>
> *The FWS's April 5, 2001 final BO concluded that Reclamation's proposed action (i.e., continued operation of the Project to deliver a water supply for irrigated agriculture and refuges) for 2001 is not likely to jeopardize the continued existence of the bald eagle. Reclamation agrees with this conclusion.*
>
> *The 2001 Annual Operations Plan for the Project, which was developed in conformance with the FWS and NMFS biological opinions, resulted in severely reduced agricultural and refuge water supplies that benefit bald eagles. Reclamation was able to obtain water in 2001 through cooperative means from water users in the Basin to provide the protections sought by the FWS, and would continue to take similar cooperative actions in the future. The BO also stated that Reclamation's action is likely to result in a significant reduction or elimination of the prey base for the bald eagle due to reduced or curtailed water deliveries to areas that contain important eagle feeding habitat. The BO included non-discretionary reasonable and prudent measures (RPM) to minimize incidental take of bald eagles.*
>
> *Reclamation believes any effects on the bald eagle that may have occurred during 2001 resulted primarily from the FWS's NMF's RPA requirements and not entirely from Reclamation's proposed actions. Certain conservation measures may be appropriate relative to long-term operations of the Project, however, and Reclamation would like to discuss these with the Service during further consultation.*
>
> *Reclamation believes that the proposed action would provide adequate water deliveries to support eagles in most years. When considered in its entirety, the proposed action may affect bald eagles*."

Reclamation's BA, on page 91 "Determination of Effects" states that:

> *"Reclamation's February 13, 2001 biological assessment stated that the proposed action (i.e. continued operation of the Project to deliver a water supply for irrigated agriculture and refuges) would provide adequate water deliveries to support eagles in most years. Reclamation believes that the effects of the proposed action in this BA would be similar to those described in the 2001 biological assessment. Therefore the proposed action may affect, but is not likely to adversely affect bald eagles."*

However in the February 13, 2001 biological assessment referenced above, Reclamation states on page 89 under determination of effects:

> *"Continuing Project operations may affect likely to adversely affect threatened bald eagles due to loss of lake and marsh habitat supporting waterfowl and fish populations in the Basin during dry years"*

As will be seen in the effects analysis below, the Service agrees with the referenced determination from 2001 that the proposed action is likely to adversely affect bald eagles, especially in dry years.

14.2 Proposed action for analysis

The Service interprets the proposed action and the table on page 53 and 54 of the BA to mean that Reclamation will manage Upper Klamath Lake, Gerber Reservoir and Clear Lake to their average minimum level for the corresponding year types (i.e. critical, dry, below average, and above average). This should result in similar conditions in the reservoirs and lakes, and deliveries to the Refuge as those experienced from 1990 - 1999.

In general, the proposed action includes periods that are likely to reduce the level of water in reservoirs during times of bald eagles nesting and wintering. Reclamation proposes that the project will be managed as it has in the years 1990 - 1999. This time period includes all types of water years from critically dry to above normal. Reduced water levels in reservoirs during nesting and wintering are likely to reduce bald eagle prey availability and prey productivity, and reduce the size of foraging areas, potentially increasing the distance between foraging areas and roosting areas. These environmental effects would likely increase competition between foraging eagles, reduce foraging efficiency, reduce fitness prior to migration to breeding grounds and potentially reduce breeding success of eagles that winter in the area.

Of the factors presented earlier in this document, nesting food supply and wintering food supply are the ones most affected by the proposed action. The discussion below focuses on food supply for specific nesting and wintering areas within the action area.

14.3 Effects on Potential Nesting on Clear Lake National Wildlife Refuge

With the expanding population of eagles in the Klamath Basin and limited foraging territories, it is possible that eagles may attempt to establish a foraging territory near Clear Lake. Water manipulation of the lake would directly affect fish populations. Initially, temporary drawdowns may make fish easier to catch. However, fish population sizes may decrease during drawdown, and when the Reservoir is reflooded the prey would be less concentrated than before the drawdown. Eagles currently use Clear Lake as an opportunistic food supply, and if that type of use continues, adverse effects would be unlikely. If foraging territories associated with nests are established on the reservoir and the reservoir level is dropped substantially, the effects on the eagles with the territories would be greater.

14.4 Effects on Nesting at Gerber Reservoir

Reservoir management could result in changes to the success of eagles feeding on fish in Gerber Reservoir. The relationship is not a simple one. Reservoir draw downs during dry years may result in temporary increases in prey availability because reduced water levels should cause increased concentrations of fish populations and fish kills making foraging easier. If more drought years follow, reservoir levels will remain very low and fish populations will continue to decline or stabilize at a lower level resulting in an overall reduction of the prey base for eagles. Even when precipitation increases and reservoir levels rise, the remaining fish populations disperse into the increasing habitat, and the resulting low densities may further reduce the opportunities for fish capture by eagles. It may take one or more spawning years for fish populations to respond to increasing habitat as water levels rise. In either case, after an initial increase, forage availability is expected to be lower for some time following periods of reservoir draw downs and this could result in a lower reproductive rate for nesting eagles.

Another mechanism for impact is competition between eagles for limited prey during reservoir drawdowns. Eagles establish feeding territories on lakes and in bodies of water which they defend from other eagles. These territories generally consist of the more shallow area of the water body because fish are easier to locate and capture there. Multiple territories around a reservoir are well known by territorial eagles and their boundaries are defended. If reservoir levels are reduced, then the foraging areas are also reduced, as are the buffer areas between territories. Reduced area between territories and smaller territories increase the likelihood and intensity of territorial disputes between nesting eagles.

During the drought in the early 1990's there were two eagle pairs using Gerber for foraging. A monitoring report in 1992, by the Bureau of Land Management, identified two distinct foraging areas defended by the two nesting eagle pairs and raised the issue of shrinking habitat increasing the competition and lowering the success of the eagles (BLM 1992). Since that time two more eagles have established nesting territories near Gerber Reservoir and forage there. One was established in 1996 and another in 1997. With the addition of two more nests in the area, the reduction in surface area of the reservoir through lowered levels could be even more disruptive to nesting success.

14.5 Effects on Nesting at Upper Klamath Lake

Bald eagles nesting at Upper Klamath Lake are less likely than other territories to be adversely affected by the proposed project. Because the primary forage species at Upper Klamath Lake (tui chubs and blue chubs) are spring spawners, they should not be significantly affected by summer and autumn draw-downs. Eagle reproduction in this zone has been between 0.99 and 1.02 young per nest as a 5 year moving average, which is within the desired range of reproduction (Isaacs and Anthony 2001).

However, there have been some habitat changes in the area that could affect foraging success. Near Upper Klamath Lake Wildlife Refuge, there has been a very noticeable loss of open shallow water near several eagle nesting and foraging territories (J. Hainline, pers. comm. 2001; R. Hardy, pers. comm. 2001). The loss is the result of the filling in of the fragmented bullrush marsh. As mentioned earlier the reason for this growth is not known but could be related to the change in depth of the lake from the historical levels. This loss of shallow open water for foraging could reduce the size of foraging areas near nests. It could also reduce the areas used by both eagles and recreationists; decreasing eagle foraging success and increasing energy demands. The proposed project does not include reducing the lake level low enough in spring to facilitate vigorous growth of bullrush, but if that situation resulted due to water demand, it would contribute, in an incremental way, to the loss of foraging areas.

14.6 Effects on Wintering Bald Eagles in the Klamath Basin

The BA does indicate the amount of water that would be delivered to Lower Klamath NWR and does not include an effects analysis for wintering eagles. As in the sections above, the Service interprets the BA to mean that Reclamation will manage Upper Klamath Lake, Gerber Reservoir and Clear Lake to their average minimum level for the corresponding year types (i.e. critical, dry, below average, and above average). This should result in similar deliveries to the Refuge as those experienced from 1990 - 1999. The most significant adverse affects to eagles would occur in the driest years, therefore the effects analysis will examine the effects to the eagles during years of limited water delivery.

As discussed above, the proposed action includes water delivery to wintering areas via operation of the Klamath Project. The water delivery affects wintering bald eagles because within the affected area, wintering bald eagles depend on waterfowl. Waterfowl depend on specific wetlands habitats. The more area covered by suitable wetlands, the greater the number, likelihood and duration of waterfowl use. Wetland habitat types and surface area depend on the amount of water delivered. Because of this series of relationships, the Service's analysis of effects of the proposed action on wintering bald eagles will examine bald eagle needs first in terms of waterfowl, then in wetland types and areas, and then the amount of water delivered.

Wintering areas that provide adequate food and areas free from harassment are possibly the most significant contribution to adult survival (Stalmaster 1987; Grier 1980; McClelland 1994). They provide an easy, low energy cost source of nutrition during times of seasonal stress. When combined with nearby roosting habitat that is protected from foul weather and harassment, the advantage to the fitness of the eagles is tremendous. It is especially valuable for immature bald eagles because when prey availability is low, immature eagles are likely to suffer the highest mortality rates (Stalmaster and Gessaman 1984).

The relationship between numbers of waterfowl and numbers of bald eagles in the Lower Klamath NWR is similar to relationships found in other areas between eagles and food.

Keister et al. (1987) found that "waterfowl populations on Lower Klamath was most important for predicting eagle use at that location". In addition, larger populations of waterfowl increase both the number of dead birds and the likelihood of dead birds from disease outbreaks (USDI and USGS, 1999). Disease outbreaks are less likely when waterfowl numbers are low.

Seasonal food sources and sites can be long term, such as the Klamath Basin or temporary sites such as local fish kills or ungulate die offs. An example of the temporary nature of some feeding sites can be seen in a study by researchers in Montana. From 1977-1993, R. McClelland studied the biology of autumn bald eagles feeding on kokanee salmon during a spawning run in Glacier National Park, Montana. Salmon had been introduced into the area in 1916 and the run of salmon had been noted to attract eagles as early as 1939. The run diminished and collapsed during his study and the population of eagles using the area diminished also. With the loss of this run and the collapse of many natural salmon runs in the Pacific Northwest (Bennetts 1997), McClelland felt that managers had ignored the importance of these food sources for adult survival and successful reproduction. He strongly recommended protecting even temporary feeding areas that can provide large amounts of food for eagles (McClelland 1994). The winter feeding sites in the Basin are natural, require little to sustain them and are the only large ones in the area. This means this valuable site would be relatively simple to perpetuate for long-term conservation of the eagle.

The relationship between the number of wintering eagles and the numbers and availability of prey has been the subject of several studies. One in north central Missouri at the Swan Lake National Wildlife Refuge found peak numbers of wintering eagles were directly related to peaks in waterfowl numbers (Griffin et al. 1982). This correlation even tracked temporary peaks in prey during the same season.

A similar positive correlation between availability of kokanee salmon and eagles was found for four of five years in a study on migrant bald eagles at Hauser Reservoir in Montana (Restani et al. 2000). Also a study on the Skagit River in Washington found the numbers of eagles present in the river area was a function of the availability of salmon carcasses (Hunt et al. 1992). Brown in 1993 found that as prey abundance increased the success rate of foraging eagles also increased (Brown 1993). The literature is clear that availability of food drives the number of eagles that a winter feeding area can hold and the success of their foraging efforts.

Relationship between Waterfowl and Bald Eagle Numbers at Lower Klamath NWR

Water delivery that changes or restricts the amount of habitat available for migrating waterfowl creates adverse effects for wintering bald eagles by reducing the capacity of Lower Klamath NWR to support overwintering waterfowl. In a study specifically related to use of communal roosts and foraging areas by wintering eagles in the Klamath Basin, Kiester et. al. 1987 found that:

> "*Waterfowl populations at Lower Klamath Refuge (r = 0.60, P < 0.05) were most important in predicting eagle use at that location , and ice cover was (r = 0.72, P ,0.05) most important at Tule Lake*".

Based on research described earlier (some specific to the Basin) on bald eagle and prey numbers, it is probable that some threshold number of waterfowl are required to avoid having adverse affects on eagles reach the point where they significantly impairing the feeding opportunity for the high concentrations of bald eagles documented to use Lower Klamath NWR. Waterfowl numbers below this threshold would likely sustain only a portion of the potential wintering population. Waterfowl numbers above the threshold would adequately sustain both relatively high and lower numbers of eagles.

Using data from Lower Klamath NWR, the Service explored the specific relationship between bald eagle and over-wintering waterfowl numbers on Lower Klamath NWR to identify a threshold number of waterfowl that would avoid significantly impairing the feeding of the high concentrations of bald eagles frequently observed wintering there. This number will be referred to as the ?threshold" or ?waterfowl threshold number" in this opinion. January aerial counts of both eagles and waterfowl between the years 1981 and 2001 were plotted against each other and a simple linear regression performed (Mauser and Thomson 2001). January data does not reflect the highest number of eagles using the Basin and Lower Klamath NWR but generally does represent the lowest number of waterfowl using the area. Therefore it marks the most difficult foraging period for the eagles present at the same time.

The resulting regression line was a relatively poor fit to the data ($r^2 = 0.2232$), due in large part to relatively higher variance in eagle numbers at high waterfowl numbers, as compared to variance in eagle numbers at lower waterfowl numbers. The pattern of the data was interpreted as likely evidence of prey swamping, a phenomenon where prey abundance surpasses predator need, so that food availability is no longer a factor in determining predator numbers (Craighead and Craighead 1956, Ricklefs 1983). The rise in the variance in eagle numbers appears to occur between 100,000 and 150,000 waterfowl. This suggests the waterfowl threshold number is between these numbers.

To more closely approximate this minimum, six additional scatter plots were produced, each including data up to, but not beyond a certain number of waterfowl (100,000, 125,000, 150,000, 200,000, 300,000, and 400,000). Each scatter plot was fitted with a regression line, and the resulting r^2 values compared. The plot of waterfowl < 125,000 had the highest r^2 value at 0.4087, a substantially better fit. Each regression line was then tested for significance via ANOVA (H_0: = 0; = 0.05), and the resulting p values compared. The plot of waterfowl < 125,000 had the lowest p value at @ 0.0008.

These results identified 125,000 waterfowl as the point before which bald eagles numbers are most strongly correlated with waterfowl numbers and after which prey swamping could explain decreases in the fit of regressions. Data analysis suggests 125,000 is the waterfowl threshold number necessary to provide adequate prey to maintain the high concentrations of eagles wintering on Lower Klamath described in the environmental baseline.

14.6.1 Verification of the Derived Waterfowl Threshold Number of 125,000

While waterfowl numbers are the main determinant of wintering eagle success, other factors such as ice cover and regional weather conditions can obviously influence prey availability and distribution in the Klamath Basin (Keister et al. 1987) and eagle immigration into the area. For example in January of 1988 when there were fewer than 125,000 waterfowl counted on Lower Klamath there were 597 eagles. However, there was an extremely large avian cholera outbreak that produced 8,000 dead ducks and geese in the peak wintering period. Thus, live waterfowl counts were low but prey items were abundant. Disease outbreaks, however cannot be predicted other than they are most likely to occur in larger populations.

Using studies on eagles we can check the approximation of waterfowl threshold against energy estimations for needs of wintering eagles. Stalmaster and Gessaman (1984) using lab measurements of captive eagles estimated that wild eagles feeding on salmon in northwestern Washington needed approximately 2,068 kilojoules of energy a day to provide their metabolic and biological energy needs under winter foraging and roosting demands. The energy value of various prey items, including Canada goose, coot and mallard was determined in a study by Stalmaster and Petner (1992). Assuming that an eagle spends from the middle of December to the middle of March (approximately 90 days) in the Basin, it would require the energy equivalent of 8 geese, or 61 coots or 28 mallards per winter. This number is in close agreement with an estimate calculated from Stalmaster's (1987) approximation that an eagle would need 135 ducks a year (approximately 33 for 3 months) for energy needs.

Because of the competition and harassment between eagles, large prey items like geese, which may have the capability to provide more than the daily requirements for 1 bird, do not get spread equally among birds. Therefore a more useful estimate might be one medium prey item (mallard) every other day or so. That would be approximately 30 to 45 prey items a winter. Dividing the eagle use season into 2 week periods results in approximately 5 periods. This in turn equates to 6 to 7 prey items per eagle per time period. For example, 600 eagles present in the Basin would need 3,600 to 4,200 prey items in a two week time period. Most of the waterfowl eaten by eagles are sick or dead (Keister et al. 1987) so barring a disease outbreak, if the natural mortality of ducks in winter is 3 to 4 percent, a steady population of 125,000 waterfowl would provide the necessary number of prey from natural mortality alone. Combined with eagles supplementing scavenging with pursuit and capture of healthy birds the 125,000 threshold appears to be adequate to provide for the number of eagles that are likely (given historical data) to winter in the Lower Klamath NWR in most years.

Information regarding the energetic needs of eagles corroborates the waterfowl threshold number of 125,000. The Service consider this threshold applies when open water for waterfowl is available and bald eagle numbers fall within the previously-documented range.

14.6.2 Derived Minimum Water Delivery to Sustain Waterfowl Habitat to Support the Waterfowl Threshold Number of 125,000

Because the proposed action is water delivery, the Service's previous analysis of waterfowl and habitat acres must be translated into water delivered. Using the above analysis, the Service estimates the minimum amount of water necessary to maintain waterfowl habitat during the wintering period sufficient to harbor 125,000 waterfowl would be 32,255 acre-feet of water delivered to the Lower Klamath NWR as described below. This analytical approach is consistent with the Implementation Plan for Recovery of the bald eagle in Washington and Oregon which states " ...maintain winter habitat sufficient to support a population of wintering bald eagles equal to or greater than the current population..." (WDW 1990).

Using the best available information, including the action agencies' data and technical assistance, the Service devised a water and habitat management method to attain a high probability of maintaining minimum habitat for 125,000 waterfowl throughout the winter while using as little water as possible. This analysis step was necessary to determine the water delivery level below which sufficient waterfowl habitat could not be maintained. The water and habitat management method will be called the threshold management strategy (TMS) and is described in Table 14.6.2-1. The TMS is based on careful water delivery to manipulate Lower Klamath NWR habitat to maximize its diversity and minimize the amount of area and water used. The TMS in Table 14.6.2-1 describes the specific Lower Klamath NWR areas that would receive the water, the season of use and rationale for use under the TMS. Table 14.6.2-1 is based on information from the environmental baseline and compares past data on waterfowl numbers and various habitat regimes to the TMS. 14.6.2- 2 information establishes that the TMS is within Lower Klamath NWR water delivery levels achieved in the past, even during critically dry years.

Table 14.6.2-1. TMS. Description of specific areas that would need to receive water, timing of water delivery and retention, and supporting rationale.

Habitat	**Acres**	**Water needs** (cfs)	**Rationale**
Seasonally flooded wetland. Units 4B, 4C,9A, 11AN, 12A	2,482	September = 61 October = 61 November = 14 **Total = 8,131 a-f**	Flooding of seasonal marshes attracts and holds preferred waterfowl prey species (mallard, pintail, wigeon) and maintains Lower Klamath NWR as a traditional waterfowl and eagle staging and wintering location.
Permanent wetland Units 2, 8B, 12C	6,053	Apr = 28 May = 41 Jun = 55 Jul = 69 Aug = 60 Sep = 45 Oct = 24 **Total = 17,719 a-f**	Provide feeding and loafing habitat for waterfowl using seasonal wetlands and flooding grain fields. Unit 2 is a primary staging area for waterfowl using KDD lands and LKNWR and is close to the Bear Valley NWR night roost. Unit 8B and 12C are close to the Mt. Dome eagle night roost. These locations are intended to minimize distance eagles travel to forage.
Small grains Units 7B, 12B, 11C	2,431	Dec = 30 Jan = 38 Feb = 36 **Total = 6,405 a-f**	Flooding of small grain fields in winter provides important food and open water to waterfowl when seasonal marshes have frozen. This practice also makes mice available to feeding eagles. Some avian cholera in waterfowl traditionally occurs in flooding grainfields making them attractive to foraging eagles.
All wetland habitats combined	8,535	**Grand total = 32,255 a-f**	

14.6.2-2. Comparison of TMS to recent past water delivery levels and habitats important to waterfowl and bald eagles on Lower Klamath National Wildlife Refuge in 1992, 1994, and a year of full water delivery (planned for 2002, Klamath Basin NWR 2002).

Year	Permanent wetland Acres	Seasonal wetland[1] Acres	Acres of Small grains[2]	Total wetland Acres	Acre-feet of Water need/use[3]	Peak fall waterfowl	January waterfowl	January eagles
2002 Habitat Plan[4]	Approx. 11,000	Approx. 8,000	Approx. 5,000	Approx. 19,000	Approx. 69,000	up to 1.8 M	up to 340K	up to 958
1992	5,005	6,258	3,986	11,263	43,930	804K	3,750	51
1994	9,104	4,955	3,648	14,059	50,974	607K	166,000	465
Minimum habitat needs	6,094	2,670	2,431	8,535	32,255	300-600K	100-200K	up to 600

[1] Flooded prior to October 31. Other wetlands would flood after this date.
[2] Flooded December, January, and February.
[3] Water need/use May-October for permanent and seasonal wetlands and Dec-Feb. for winter irrigation of grain.
[4] Water management planning assuming full water delivery to Lower Klamath NWR sufficient to meet the refuge's legislated purposes for a full range of endemic species.

As Table 14.6.2-2 indicates, the TMS is less water than was delivered in the years of 1992 and 1994. Both were "critically dry" water years, the lowest category of water availability. The average water delivery to the Refuge in those years was 47,452 acre feet of water. Therefore, the Service assumes that Reclamation's proposed action; to deliver that amount or more in all year types in the next 10 years, will meet the TMS minimum.

The TMS would avoid significant impairment of prey availability due to water management by providing habitat sufficient for the waterfowl threshold number, if the Service's calculations are correct, and waterfowl populations do not drop due to weather or other conditions. The TMS habitat configuration would crowd waterfowl into relatively smaller areas, and make them more susceptible to predation by eagles. The Service notes this scenario is very simplistic and therefore has a certain amount of risk associated with its conclusion and it also does not eliminate adverse affects to bald eagles from reduced waterfowl habitat.

In a review of the waterfowl threshold analysis Manning and Edge (2001) discussed the uncertainty behind the assumptions in the TMS analysis. For example they raised concerns that the eagle surveys might substantially underestimate the total number of eagles that use the basin. Also that greater than the historic level of eagles might migrate to the Basin for winter food. They were also concerned that the analysis focused only on Lower Klamath NWR which might underestimate the effects of water manipulation in the entire Basin. These concerns are valid.

The Service recognizes that managing for the minimum waterfowl/water needed includes some degree of risk that the minimum is not fully adequate to sustain a varying population of wintering bald eagles. Therefore Reclamation's proposal to deliver the average for the period 1990 - 1999 (this would mean approximately 47,452 acre feet to Lower Klamath in critical dry years) which would exceed the TMS level would reduce the risk of managing only to the bare minimum. This is especially useful since the TMS is not predicted to eliminate adverse affects to eagles and does not fully support other fish and wildlife species on the refuge.

As discussed in the environmental baseline section, over the last 9 years Reclamation has halted or interrupted water supplies to the Lower Klamath NWR four times (not including 2001). The resulting adverse affects of those changes to water availability have varied depending on many factors. In 1992 and 1994, even with interrupted delivery, the refuge received more water than the TMS, as indicated in Table 3. However amount of water delivered is not the only consideration. Even delivery of more water than the TMS total of 32,255 acre-feet delivered in the wrong season may not avoid significant impairment of prey availability.

14.7 Summary of Effects

The proposed action is interpreted by the Service as providing the average water delivery by year type as occurred in the previous decade. Implementation of the proposed operation is likely to adversely affect foraging areas used by nesting and wintering bald eagles. The exact magnitude and extent of these effects cannot be easily calculated, but the general nature of these effects is well understood and supported by the best available scientific information. The effects to wintering eagles will range from a level of insignificance during years of full delivery to Lower Klamath NWR to adverse effects during years of reduced delivery.

As water delivery drops from full delivery, fish and waterfowl numbers are also likely to fall and as waterfowl numbers drop, impacts on eagles would likely increase and the total number of eagles impacted would also likely increase. The most significant effects from the proposed action are likely to occur to wintering eagles.

The Service's analysis suggests that significant impairment to the food availability to wintering eagles occurs when less than 125,000 waterfowl are present on Lower Klamath NWR. This same analysis suggests that approximately 32,000 acre feet of water is needed to consistently produce the waterfowl minimum.

Reclamation has delivered in every year from 1990 - 1999 more than 32,000 acre feet of water to Lower Klamath NWR. Therefore the proposed action of delivering water in a manner similar to the minimums of the past decade would exceed the minimum of the TMS. Even in critically dry years the adverse effects (of less than complete habitat maintenance) should not reach a level of significant impairment of wintering bald eagles feeding behavior.

14.7.1 <u>Range-wide Perspective</u>.

Maintenance of existing conservation efforts is suggested by the area-specific Recovery Plans for the bald eagle as a conservation need, with particular emphasis on maintenance of existing adult breeding eagles. Wintering habitat was identified as a particularly important aspect of maintaining adult breeding eagles. The proposed action would not change most existing conservation efforts throughout the range, but would not maintain conservation efforts in the Klamath Basin related to foraging resources for wintering and nesting bald eagles.

14.7.2 Pacific States Recovery Area Perspective.

The Pacific States Bald Eagle Recovery Plan identified four recovery criteria, and below each is compared against the effects of the proposed action.

1. The PRA should have a minimum of 800 nesting pairs.

In 1998, there were approximately 1,480 nesting pairs in the Pacific Recovery Area (USDI 1999b), including the action area. In addition, a large, but unknown number of non breeding adult and immature eagles occur in the Pacific Recovery Area (PRA) and in the action the area. Currently, the number of nesting pairs in the PRA is almost twice the recovery goal of 800 for the area and is increasing. The effects of the proposed action could cause a small reduction in the nesting success of the 120 pairs that currently use the Klamath Basin. Given the large number of nests as compared to the estimate of 800 needed to recover the species, the reduction in nesting success of bald eagles is not likely significant.

2. PRA pairs should produce an annual average of at least one fledged young per pair, with an average success rate per occupied territory not less than 65% over a five year period.

The five year nesting success of bald eagles in the Klamath Recovery Zone is 64% and 62% in Oregon. The proposed action may reduce nesting success on 120 pairs, as indicated above, but the significance of this reduction is not immediately clear. For example, one reason the nesting success is already below the recovery goal may be related to the relatively high dense nesting use, nearly double that anticipated in the nesting pairs recovery goal (1, above). Eagles that nest in close proximity to one another compete for the same resources, and have been observed to injure each other during competitive interactions. The relatively large number of nests in close proximity to one another may preclude achievement of this recovery goal. It may not be necessary to fully achieve this recovery goal to achieve recovery. As indicated earlier, the longevity of bald eagles makes survival of individual birds potentially more important than maintenance of high reproductive rates. Conversely, failure to achieve this recovery goal may also be an indication of a serious loss of available nesting territories necessary for recovery. However, because the number of nesting pairs is so much greater than the recovery goal, the combination of higher numbers of pairs but lowered per pair nesting success is likely suitable for recovery and the effect of the proposed action on up to 120 pairs is not likely significant, in and of itself.

3. PRA recovery goals must be met in at least 80% of the management zones.

The Klamath Basin contains 1 recovery zone, or roughly 2% of the recovery zones in the PRA. The Klamath Basin Recovery Zone exceeded the goals for nesting pairs, but does not achieve the nesting success rate of #2, above. The effects of the proposed action on the recovery goals 1 and 2 are discussed above. The effect of the proposed project on the population recovery goals of other recovery zones are related to wintering, and are discussed in wintering, 4, below. Overall, the Pacific Recovery Area has nearly met this goal, with 76% of recovery zones at or exceeding criteria for number of pairs (USDI, 1999b).

4. Wintering populations greater than 100 individuals should be stable or increasing.

This recovery goal applies to all individual wintering areas, including the Klamath Basin wintering areas that would be affected by the proposed action. Under the proposed action, the trend in the predictability, abundance, and availability of waterfowl for wintering eagles cannot be described as stable. The average number of eagles counted in the Klamath Basin in winter counts is approximately 375 but varies widely, up to1,100. The proposed action may adversely affect bald eagles that winter in the Klamath Basin, as described above. The proposed action would adversely affect wintering habitat and individual bald eagles that use the habitat to varying degrees, depending upon many factors. The Service's analysis shows the Klamath Project can be operated to provide adequate water delivery to the Lower Klamath NWR bald eagle wintering area to maintain waterfowl numbers above the threshold necessary to maintain concentrations of bald eagles as large as any recorded.

15.0 CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. No additional cumulative effects have been identified at this time.

16.0 CONCLUSION

After reviewing the current status of the bald eagle, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that proposed operation of the Reclamation's Klamath Project, is not likely to jeopardize the continued existence of the bald eagle. No critical habitat is designated for the bald eagle and, therefore, none will be affected. The Service reached this conclusion for the following reasons:

> Though the proposed action will result in a range of adverse effects to bald eagles, the type and intensity of adverse effects to nesting and wintering eagles is not likely to lead to death or injury of eagles by significantly impairing essential behavioral patterns such as breeding, feeding or sheltering.
>
> The TMS analysis combined with extensive literature review support a conclusion that the TMS would avoid significant impairment of bald eagle essential behaviors such as feeding, breeding and sheltering. The proposed action includes delivery of water to the Lower Klamath NWR in excess of the TMS.
>
> The number of adversely affected nesting bald eagles would be only a small proportion of the total breeding and non breeding population in the Pacific Recovery Area. Because the

nesting population of the Pacific Recovery Area already greatly exceeds the recovery goal, it seems probable that the adverse affects can be compensated.

The bald eagle has met most numerical population goals in the United States and has a reported total population that exceeded 5,748 pairs in 1998. The recovery of the species has been broad based across most of the eagles range with the population essentially doubling every 7 or 8 years since 1970 (USDI 1999b).

17.0 INCIDENTAL TAKE STATEMENT

Sections 4(d) and 9 of the Act, as amended, prohibit taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct) of listed species of fish or wildlife without a special exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is any take of listed animal species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this incidental take statement.

No take is anticipated by the proposed action.

17.1 Reasonable and Prudent Measures

Since no take is anticipated no Reasonable and Prudent measures are necessary.

17.2 Terms and Conditions

Since no Reasonable and Prudent Measures are necessary there are no implementing Terms and Conditions.

18.0 COORDINATION WITH OTHER WILDLIFE LAWS

To the extent that this statement concludes that take of any threatened or endangered species of migratory bird will result from the agency action for which consultation is being made, the Service will not refer the incidental take of any such migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, as amended (US 1918), or the Bald Eagle Protection Act of 1940, as amended (US 1940), if such take is in compliance with the terms and conditions (including amount/or number) specified herein.

19.0 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service offers the following conservation recommendations:

1. Reclamation should work toward habitat enhancement and winter irrigation of small grains at Tule Lake to return it to its former role as a feeding area for wintering waterfowl and eagles.

2. Reclamation should aggressively implement strategies to improve wetland and agricultural habitat to conditions that will increase the number of overwintering waterfowl on Tule Lake NWR for the benefit of wintering bald eagles.

3. Reclamation should work toward the burial of power lines on the refuge and other areas where infrastructure is powered by overhead power lines.

4. Reclamation should collaborate with Refuge staff to determine the origin and destination of eagles that use the Basin as a wintering area. This collaboration may include wing marking, satellite telemetry, or other systems to determine the origin or destination of wintering eagles.

20.0 REINITIATION NOTICE

This concludes formal consultation on Reclamation's proposed operation of the Project from June 1, 2002, to March 31, 2012. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required when discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that cause an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

Examples of situations that the Service believes might meet one of the prescribed reinitiation thresholds would be:

1) A frequency of dry or critically dry water year types that was not anticipated in the BA or BO;

2) Declines in the population trends of UKL sucker populations or catastrophic fish kill; or
3) A review of the final National Academy of Science report reveals significant new information

If you have any questions regarding this opinion, please contact the Project Leader of the Klamath Falls Fish and Wildlife Office at (541) 885-8481.

21.0 LITERATURE CITED

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