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Memorandum

To: Regional Director, Pacific Southwest Region,
Sacramento, California

From: Field Supervisor, Klamath Falls Fish & Wildlife Office,
Klamath Falls, Oregon 

Subject: Formal Intra-Service Section 7 Consultation for the Issuance of an Endangered Species Act, Section 10(a)(1)(B) Incidental Take Permit for PacifiCorp's Klamath Hydroelectric Project Interim Operations Habitat Conservation Plan for Lost River and Shortnose Suckers, California and Oregon

This memorandum transmits the U.S. Fish and Wildlife Service's (Service), intra-service biological opinion (BO) based on review of the subject permit application and associated Habitat Conservation Plan (HCP), in accordance with Section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*). The Applicant (PacifiCorp) has applied for an incidental take permit for take of the federally-endangered Lost River sucker (*Deltistes luxatus*) and shortnose sucker (*Chasmistes brevirostris*), as a result of normal operations and maintenance of the Applicant's Klamath River hydroelectric facilities.

The incidental take permit for the two endangered suckers would be in effect for 10 years and authorizes a combined annual lethal take of both species of up to approximately 10,000 sucker eggs, 66,000 larvae, 500 juveniles, and 5 adults, and an annual harassment take of approximately 1,400,000 larvae, 6,700 juveniles, and 25 adults. Under the proposed HCP, estimated lethal take of listed suckers by the Applicant is reduced by 90 percent from previous levels.

Seven facilities would be covered by the HCP: East Side and West Side facilities located on the Link River in Oregon; and Keno, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate Dams located on the Klamath River in Oregon and California. The proposed HCP describes the Applicant's proposed strategy for avoiding, minimizing, mitigating, and monitoring the impacts of the taking on the listed suckers from the covered activities. The proposed action consists of taking the East Side and West Side turbines offline, where most of the take occurs, and implementing a "Sucker Conservation Program" to fund projects that support sucker recovery

based on recommendations in the Service's revised 2013 recovery plan and from recommendations from the Klamath Sucker Recovery Implementation Program.

This BO finds that authorization of the incidental take permit would not likely lead to jeopardy of the listed suckers or adverse modification of their critical habitat because: (1) the amount of authorized take under the proposed HCP is reduced substantially from historic levels; (2) most of the authorized take is of sucker eggs and larvae that are produced in large numbers annually; (3) sucker populations in the hydropower reservoirs are not self-supporting and are likely dependent on upstream source populations to maintain themselves; (4) were it not for the reservoirs that are part of the Project, habitat for the Lost River and shortnose suckers would not exist below Keno Dam; (5) none of the Lost River and shortnose suckers that occur in the reservoirs below Keno Dam have adequate upstream access, and therefore these fish do not contribute to reproducing populations upstream that are essential for recovery; and (6) adverse effects to designated critical habitat by the Project are confined to Keno Reservoir, which represents a small fraction (~1%) of the total amount of designated critical habitat for the two species.

This BO is based on information included in PacifiCorp's Interim Operations Habitat Conservation Plan (PacifiCorp 2013), correspondence between the Service and PacifiCorp, and other information present in our files. The complete file for this consultation is located at the Service's Klamath Falls Fish and Wildlife Office in Klamath Falls, Oregon.

If you have any questions regarding this document, please contact me or Ron Larson of my staff at (541) 885-2506.

**Intra-Service Biological Opinion
Regarding Effects to Endangered Lost River and Shortnose Suckers
from Authorization of an Endangered Species Act,
Section 10(a)(1)(B) Incidental Take Permit to PacifiCorp
for Operation of the Klamath Hydroelectric Project
on the Klamath River in Southern Oregon and Northern California**



Prepared by the U.S. Fish and Wildlife Service

Klamath Falls Fish and Wildlife Office, Klamath Falls, Oregon

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List of Abbreviations and Acronyms

AFA	<i>Aphanizomenon flos-aquae</i>
BO	biological opinion
BOD	biological oxygen demand
C	Celsius
CDFG	California Department of Fish and Game (now CDFW)
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
cm	centimeter
DO	dissolved oxygen
EA	environmental assessment
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
HCP	habitat conservation plan
ITP	incidental take permit
KLS	Klamath largescale sucker (<i>Catostomus snyderi</i>)
LRS	Lost River sucker (<i>Deltistes luxatus</i>)
m	meter
mg/l	milligrams/liter
mm	millimeter
NCRWQCB	North Coast Regional Water Quality Control Board
NMFS	National Marine Fisheries Service
NRC	Natural Research Council
NRCS	Natural Resource Conservation Service
NWR	National Wildlife Refuge
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
OSU	Oregon State University (Department of Fisheries and Wildlife)

PCE	primary constituent elements
PIT	passive integrated transponder
pH	hydrogen ion concentration
Project	Klamath Hydroelectric Project
Reclamation	U.S. Bureau of Reclamation
RM	river mile
Service	U.S. Fish and Wildlife Service
SNS	shortnose sucker (<i>Chasmistes brevirostris</i>)
SOD	sediment oxygen demand
TMDL	total maximum daily load
TNC	The Nature Conservancy
UKL	Upper Klamath Lake
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

1.0 INTRODUCTION

This intra-Service Endangered Species Act, Section 7 biological opinion (BO) is based on information in the Applicant's (PacifiCorp) Interim Operations Habitat Conservation Plan (HCP; PacifiCorp 2013) and correspondence between the U.S. Fish and Wildlife Service (Service or USFWS) and the Applicant, as well as information present in our files. A complete administrative record of this consultation is on file at the Service's Klamath Falls Fish and Wildlife Office, 1936 California Avenue, Klamath Falls, Oregon 97601. The Service has worked with the Applicant on this HCP since 2009.

1.1 Consultation History

In 2007, the Federal Energy Regulatory Commission (FERC) consulted with the Service under Section 7(a)(2) of the Endangered Species Act (Act or ESA) on the effects of PacifiCorp's Klamath Project (Project) operations on listed species (USFWS 2007a). The Federal nexus for that consultation was the FERC's presumed issuance of a long-term license for operation of the Project. However, the license was never authorized by the FERC, and the FERC chose not to consult on the annual licenses issued to PacifiCorp. Consequently, the 2007 BO did not take effect and as a result the Applicant was left without incidental take authorization. Therefore, the Applicant has applied for an incidental take permit under Section 10(a)(1)(B) of the Act. The Notice of Availability of the HCP and draft environmental assessment (EA) was published in the Federal Register on January 28, 2013 (78 FR 5830).

2.0 DESCRIPTION OF THE PROPOSED ACTION

2.1 Action Area

The "action area" is defined in 50 CFR §402.02 as "...all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." Based on information contained in the draft HCP and draft EA, we have determined that the action area for this consultation are water bodies extending from the outlet of Upper Klamath Lake (UKL) in southern Oregon, downstream in the Klamath River to Iron Gate Dam in northern California (Figure 1), a distance of approximately 64 river miles (RM). Water bodies within the action area include: Link River, Keno Reservoir including Lake Ewauna, the Klamath River, and J.C. Boyle, Copco No 1, Copco No. 2, and Iron Gate Reservoirs.

2.2 Proposed Action

The Service plans to issue an ESA Section 10(a)(1)(B) incidental take permit (ITP) to the Applicant for take of the federally-endangered Lost River sucker (LRS, *Deltistes luxatus*) and shortnose sucker (SNS, *Chasmistes brevirostris*). The ITP for the two endangered suckers would be in effect for 10 years and authorizes a combined annual lethal take of both species of up to approximately 10,000 sucker eggs, 66,000 larvae, 500 juveniles, and 5 adults, and an annual harassment take of approximately 1,400,000 larvae, 6,700 juveniles,

and 25 adults as a result of normal hydroelectric operations at seven Klamath River Basin facilities owned and operated by the Applicant. These facilities include: East Side facility, West Side facility, and the following dams: Keno, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate (Figure 2.1). The Fall Creek Powerhouse, an additional PacifiCorp hydroelectric facility located in the Klamath Basin, will not be covered by this HCP because its operations have no known effect on listed species. Therefore the Fall Creek facility will not be further mentioned in this BO.

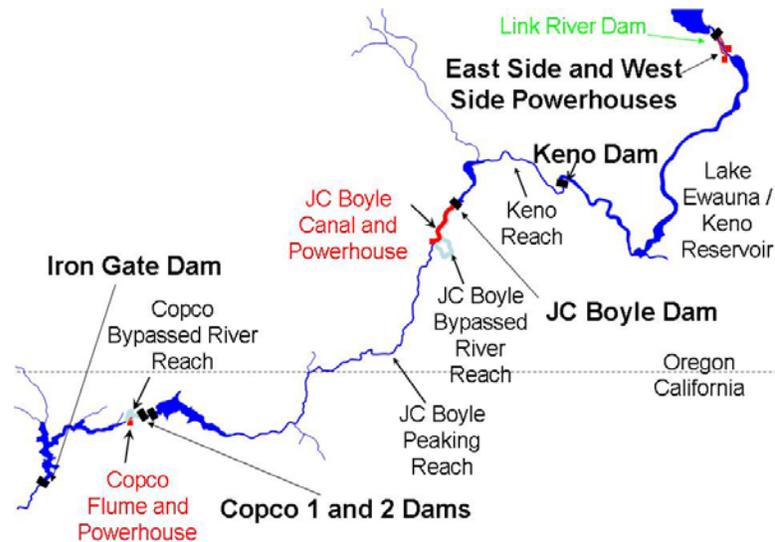


Figure 2.1 Map of the Klamath River showing the 7 hydroelectric facilities covered by the proposed HCP. Also shown is the Link River Dam, which is not part of the HCP.

PacifiCorp's HCP describes the strategy for avoiding, minimizing, mitigating, and monitoring the impacts of the taking of listed species by the covered activities (PacifiCorp 2013). Covered activities under the HCP include actions that are necessary to operate and maintain Project facilities during the permit term as described in Chapter II of the HCP. In support of the Applicant's permit application, and in accordance with Section 10(a)(2)(A) of the ESA and the Service's implementing regulations, PacifiCorp, with the assistance from the Service, prepared the Interim Operations Habitat Conservation Plan for Lost River and Shortnose Suckers (PacifiCorp 2013), that specifies:

1. Impacts to listed species likely to result from the taking;
2. Steps the Applicant will take to avoid, minimize, mitigate, and monitor the effects, the funding that will be available to implement such steps, and the procedures necessary to deal with unforeseen circumstances;
3. Alternatives to the taking that were considered by the Applicant and reasons why they were not utilized; and
4. Measures the Service considers necessary or appropriate for purposes of the HCP.

The following is a description of the Project and an overview of PacifiCorp's proposed HCP.

2.3 Project Description

The Applicant's Project to be covered under the proposed HCP and ITP consists of five Klamath River mainstem dams and associated reservoirs: Keno, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate; additionally two Link River facilities located near the outlet of UKL, East Side and West Side developments, are part of the Project (Figure 1; PacifiCorp 2013). All of the dams with the exception of Keno Dam are equipped with powerhouses and turbines for electric power generation. PacifiCorp has operated the Link River Dam under a 1956 agreement with the Bureau of Reclamation (Reclamation), who owns the dam. PacifiCorp operates the dam at Reclamation's direction. Operations at the Link River Dam affecting listed species, with the exception of the East Side and West Side facilities that are owned by PacifiCorp, are covered by a 2013 BO issued to Reclamation (NMFS and USFWS 2013).

PacifiCorp's Project operations are described in detail in FERC (2007) and in the Service's 2007 BO (USFWS 2007a) on the proposed Project relicensing by FERC. Additional information on the Project and the affected area is available in the Klamath Facilities Removal Environmental Impact Statement/Environmental Impact Report (USDI and CDFW 2013). Table 2.1 summarizes dam, powerhouse, and reservoir information for the seven Project developments located on the Klamath River. The following information is taken from PacifiCorp's HCP (PacifiCorp 2013).

East Side and West Side Developments

The East Side and West Side developments are located just downstream of Link River Dam at the outlet of UKL at river mile (RM) 254.3. PacifiCorp generates electricity at the East Side and West Side facilities using water diverted at Link River Dam.

The East Side facilities consist of: (1) a 670 foot-long mortar and stone canal; (2) an intake structure; (3) 1,729 feet of 12-foot-diameter, wood-stave flow line; (4) 1,362 feet of 12-foot-diameter, steel flow line; (5) a surge tank; and (6) a powerhouse. Maximum diversion capacity for the East Side powerhouse is 1,200 cubic feet per second (cfs). The West Side development facilities consist of: (1) a 5,575-foot-long concrete-lined and unlined canal; (2) a spillway and discharge structure; (3) an intake; (4) 140 feet of 7-foot-diameter steel penstock; and (5) a powerhouse. The maximum diversion capacity of the West Side powerhouse is 250 cfs. Water at Link River Dam flows through the spillway gates and is diverted to East Side or West Side developments, after which it enters the Link River and flows into the Keno Reservoir.

Table 2.1. Information on the existing Klamath Hydroelectric Project development (source: PacifiCorp 2013).

Item	East Side and West Side	Keno	J.C. Boyle	Copco No. 1	Copco No. 2	Iron Gate
Dam and Powerhouse Information						
Completion Year	East Side: 1924 West Side: 1908	1967	1958	1918	1925	1962
Dam Location (River Mile)	254.3	233.0	224.7	198.6	198.3	190.5
Dam Height (feet)	---	25	68	126	33	173
Powerhouse Location (River Mile)	East Side: 253.7 West Side: 253.3	None	220.4	198.5	196.8	190.4
Powerhouse (Turbines) Hydraulic Capacity (cfs)	East Side: 1200 West Side: 250	None	3,000	2,962	3,300	1,735
Reservoir Information						
Reservoir Length (miles)	---	22.5	3.6	4.6	0.3	6.2
Maximum Surface Area (acres)	---	2,475	420	1,000	40	944
Maximum Depth (feet)	---	19.5	41.7	115.5	28	162.6
Normal Annual Operating Fluctuation (feet)	---	0.5	5	6.5	NA	4.0

Table 2.1. Information on the existing Klamath Hydroelectric Project development (source: PacifiCorp 2013).

Item	East Side and West Side	Keno	J.C. Boyle	Copco No. 1	Copco No. 2	Iron Gate
Total Storage Capacity (acre-feet)	---	18,500	3,495	46,867	73	58,794
Active Storage Capacity (acre-feet)	---	495	1,724	6,235	Negligible	3,790
Reservoir Retention Time (days)						
At 710 cfs	---	13	2.5	32	0.052	42
At 1,500 cfs (near average)	---	6	1.2	15	0.025	20
At 3,000 cfs	---	3	0.6	8	0.012	10

Keno Dam

The Keno Dam is a regulating facility owned by PacifiCorp that controls the water level of the Klamath River at RM 233, creating Keno Reservoir (also called “Keno Impoundment”), an impoundment that extends 22.5 miles upstream to the outlet of the Link River. The normal maximum water surface of Keno Reservoir is at elevation 4,086.5 feet. Keno Reservoir has a surface area of 2,475 acres at elevation 4,085 feet and a total storage capacity of 18,500 acre-feet.

PacifiCorp operates Keno Dam under an agreement with Reclamation, the execution of which was required by Article 55 of PacifiCorp’s original FERC license. According to a 1968 contract between PacifiCorp and Reclamation for the operation of Keno Reservoir, the reservoir should generally be maintained at a water level between elevations 4,085.0 and 4,086.5 feet (USBR datum). Maintenance of a stable water level in Keno Reservoir facilitates consistent water delivery to dependent water users. Gravity flow from Keno Reservoir provides water either directly or indirectly to about 40 percent of the lands irrigated by Reclamation’s Klamath Project as well as to the Lower Klamath Lake National Wildlife Refuge.

Keno Dam does not include power-generating equipment, but it has a 24-pool weir and orifice-type fish ladder that gains 19 feet in elevation over a length of 350 feet. The ladder was designed to pass trout; however, the ladder likely presents an impediment to passage by listed suckers that do not effectively use a pool and weir-type fish ladder designed for salmonids because they are not likely to jump over weirs (USFWS 2007a).

J.C. Boyle Development

The J.C. Boyle development consists of a reservoir, a combination embankment and concrete dam, a screened intake structure and water conveyance system, a fish ladder designed to pass trout and a powerhouse on the Klamath River between about RM 228.3 and 220.4. J.C. Boyle Dam impounds a narrow reservoir of 420 surface acres (J.C. Boyle Reservoir) from RM 228.3 to 224.7. The reservoir contains approximately 3,495 acre-feet of total storage capacity and 1,724 acre-feet of active storage capacity.

The J.C. Boyle Dam intake structure is a 40-foot-high reinforced concrete tower. Water at J.C. Boyle Dam either flows through the intake and enters the water conveyance system and then the powerhouse or is discharged back into the Klamath River. J.C. Boyle Dam includes an approximately 569-foot-long pool and weir fishway for upstream fish passage. Flow into the ladder is approximately 80 cfs. A 24-inch-diameter fish screen bypass pipe provides about 20 cfs of flow below the dam.

The J.C. Boyle powerhouse is located at RM 220.4, approximately 4 miles downstream of the dam. The powerhouse contains two vertical-Francis turbines, each with a rated discharge of 1,425 cfs. The reach between the dam and powerhouse is referred to as the J.C. Boyle bypass reach. Substantial groundwater enters the J.C. Boyle bypass reach starting about 0.5 mile downstream of the dam. The average accretion in the bypass reach is between 220 and 250 cfs and is relatively constant on a seasonal basis (FERC 2007). From the powerhouse, river flows pass through a 17.3-mile-long reach referred to as the J.C. Boyle peaking reach, before entering Copco No. 1 Reservoir at RM 203.1.

Copco No. 1 Development

The Copco No. 1 development consists of a reservoir, dam, spillway, intake, and outlet works and powerhouse located on the Klamath River between RM 203.1 and 198.6 near the Oregon-California border. Copco No. 1 Dam impounds a reservoir of 1,000 surface acres (Copco Reservoir) from RM 198.6 to 203.1. Copco Reservoir contains approximately 33,724 acre-feet of total storage capacity at elevation 2,607.5 feet and approximately 6,235 acre-feet of active storage capacity. The normal maximum and minimum operating levels of the reservoir are at elevations 2,607.5 and 2,601.0 feet, respectively. The Copco No. 1 powerhouse is located at the base of the dam. The two turbines are double-runner, horizontal-Francis units, each with a rated discharge of 1,180 cfs. Water from Copco No. 1 Dam passes directly into Copco No. 2 Reservoir either via the powerhouse or through spillage.

Copco No. 2 Development

The Copco No. 2 development consists of a relatively short diversion dam and small impoundment just downstream of Copco No. 1 Dam, a water conveyance system, and a powerhouse located on the Klamath River between RM 198.6 and 196.9. The reservoir is about 0.25 miles long and has a relatively small storage capacity of 73 acre-feet.

The Copco No. 2 powerhouse is located approximately 1.4 miles downstream of the diversion dam at RM 196.9. The powerhouse is a reinforced concrete structure that houses two vertical-Francis turbines. Each turbine has a rated discharge of 1,338 cfs. The reach between the diversion dam and powerhouse is referred to as the Copco No. 2 bypass reach. Water at Copco No. 2 Dam either enters the flow conduit to the Copco No. 2 powerhouse or the Copco No. 2 bypassed reach, after which it enters Iron Gate Reservoir.

Iron Gate Development

The Iron Gate development consists of a reservoir, an earth embankment dam, spillway, intake, and outlet works and powerhouse located on the Klamath River between RM 196.9 and 190.1, approximately 20 miles northeast of Yreka, California. Iron Gate Dam impounds a reservoir of 944 surface acres (Iron Gate Reservoir) from RM 190.1 to 196.9 that contains about 50,941 acre-feet of total storage capacity (at elevation 2,328.0 feet) and 3,790 acre-feet of active storage capacity. The Iron Gate powerhouse is located at the base of the dam. The Iron Gate powerhouse consists of a single vertical Francis turbine. The turbine has a rated discharge capacity of 1,735 cfs.

2.4 Description of PacifiCorp's Proposed Interim Operations Habitat Conservation Plan

2.4.1 Sucker Conservation Strategy

The Sucker Conservation Strategy identifies take minimization and mitigation measures that respond directly to the sources of potential take that may occur as a result of PacifiCorp's covered activities during interim operations that will occur until PacifiCorp receives a long-term operations license from the FERC (PacifiCorp 2013). The strategy focuses on two conservation components for listed sucker species. First, PacifiCorp will avoid/minimize take of listed suckers at its East Side and West Side hydroelectric facilities within 30 days after issuance of the ITP by substantially limiting operations and reducing flow through the facilities. Until the facilities are decommissioned, further operations, if any of the East Side and West Side facilities will be greatly reduced because the turbines will not operate, except for brief (<1 day) testing,

during times when suckers are unlikely present; however, there will be an 80 cfs flow through the East Side wood-stave, flow line to prevent it from collapsing. FERC relicensing is required to decommission the East Side and West Side facilities and PacifiCorp must maintain and annually test the facilities until the facility is formally decommissioned. Second, PacifiCorp will improve habitat conditions for listed suckers by facilitating the implementation of specific enhancement projects consistent with the revised recovery plan and supporting The Nature Conservancy's (TNC) Williamson River Delta Restoration Project. The conservation strategy described below is intended to minimize and mitigate the potential for take of listed suckers resulting from continued operations over the permit term.

Sucker Biological Goals and Objectives

The overarching biological goal of the Applicant's proposed HCP is to contribute to the conservation of Lost River and shortnose suckers on covered lands during the interim period. This goal will be achieved through implementation of measures that avoid or minimize the direct effects of PacifiCorp's operation (e.g., entrainment) on individual suckers and by funding enhancement efforts to benefit listed suckers. While these goals are not quantitative, they are measurable as described below. More specific goals and objectives of the strategy, and measures to address the objectives, include the following:

Goal I: Minimize take associated with interim operations of the Project facilities

Objective A: Minimize entrainment at the East Side and West Side hydroelectric facilities to enhance sucker survival in the Klamath River above Iron Gate Dam by substantially reducing operations at these facilities.

Most of the estimated take of listed suckers associated with Project operations is related to operation of the East Side and West Side turbines. Based on a review of relevant literature, the Service estimated that 25 percent of the suckers passing through turbines are killed (USFWS 2007a). With reduced operations at the East Side and West Side facilities, potential Project impacts on listed suckers will be substantially reduced, and the residual sources of potential take would be mostly restricted to the downstream reservoirs that created artificial habitats outside of the historic range, and where suckers contribute less to recovery.

Goal II. Improve the viability of the listed sucker populations

Objective A: Increase the amount or quality of available sucker habitat.

This objective is important because the amount and quality of available sucker habitat is presently limited due to existing habitat conditions in the Project area. Increasing the availability of key sucker habitats will help improve spawning and rearing conditions prior to Project removal.

This goal and objective are to improve the viability of the listed sucker populations by offsetting the impact of the potential take of individuals is measureable by demonstrating the effectiveness of improvements conducted under the Sucker Conservation Fund and support of the Williamson River Delta Restoration Project. This would be accomplished by quantifying the units of habitat created or restored (e.g., acres of habitat or linear feet) or by demonstrating use of those restored sites by suckers.

2.4.2 Measures Undertaken to Achieve Objectives

To address Objective I.A, PacifiCorp will substantially reduce operations at the East Side and West Side facilities within 30 days of the date of issuance of the ITP by the Service, as mentioned above. The facilities would remain in place and a small flow (up to 80 cfs) would move through them until they are decommissioned through the FERC licensing process. PacifiCorp will continue to maintain the facilities such that limited operations for testing or maintenance purposes are possible prior to decommissioning of the facilities. Further power generating operations of these facilities, if any, would take place only during periods when take of listed suckers is unlikely to occur, such as during periods of low species presence. To ensure that these brief operations would not likely affect listed suckers, PacifiCorp will contact the Service no later than 30 days before any such operations for testing or maintenance purposes to provide information on the planned operations and allow the Service to recommend possible modifications of the planned operations to avoid take of listed suckers.

Shutdown of the East Side and West Side turbines prior to decommissioning will reduce adverse effects to listed suckers. Specifically, the shutdown will result in additional benefits to listed suckers by reducing possible entrainment, ramping events, and false attraction to powerhouse tailraces.

To address Objective II.A, PacifiCorp will fund activities that enhance sucker habitat or otherwise promote the survival and recovery of listed sucker species. PacifiCorp will accomplish this by establishing a fund to support sucker recovery actions and providing continued support of the Williamson River Delta Restoration Program for the duration of the permit term.

Sucker Recovery Initiatives

Within 90 days following issuance of the ITP, PacifiCorp will make an initial contribution of \$40,000 to the Sucker Conservation Fund to support initiatives that promote sucker recovery. PacifiCorp will also support recovery initiatives by contributing an additional \$30,000 to the fund on the fourth anniversary of the ITP and another \$30,000 on the seventh anniversary. The total fund contribution over the permit term will be \$100,000. This funding will be used to support and implement actions that increase the viability of the sucker populations consistent with the Service's revised Lost River sucker and shortnose sucker recovery plan (USFWS 2013a). The funding schedule outlined above will ensure that mitigation funding is available prior to potential incidental take occurring from Project operations during the permit term and will allow sucker recovery initiatives to be adequately planned and implemented to mitigate potential incidental take.

Recommendations for projects to be funded by the Sucker Conservation Fund will be provided by the Klamath Sucker Recovery Implementation Program. The revised recovery plan for the Lost River sucker and shortnose sucker (USFWS 2013a) calls for the establishment of a program to coordinate implementation of recovery actions identified in the plan as necessary for recovery of these species. Because the Klamath Sucker Recovery Implementation Program will have experts within the fields relevant to sucker recovery and is generally responsible for the prioritization and coordination of activities, the Klamath Sucker Recovery Implementation Program will be in a position to provide recommendations to PacifiCorp for use of the Sucker Conservation Fund that are based upon the best available scientific information.

Examples of potential sucker recovery actions that could be implemented with the Sucker Conservation Fund include the following: (1) restoration/enhancement of spawning areas in

UKL or in its tributaries; (2) capture of adult suckers in downstream reservoirs and relocation to UKL; and (3) controlled propagation of suckers. Any of these three potential projects listed above, or others, could increase sucker reproduction in UKL and thus promote their recovery.

The Sucker Conservation Fund will initially be administered by the National Fish and Wildlife Foundation (NFWF)¹. If, for any reason, a different administrator is required during the permit term, PacifiCorp and USFWS will select a new administrator with demonstrated capability to successfully carryout the administration of the fund. NFWF will administer the fund upon receiving a list of sucker enhancement projects specified by PacifiCorp based on recommendations from the Klamath Sucker Recovery Implementation Program as described above. Thereafter, NFWF will be responsible for overseeing contracting with parties for the projects with funds provided from the Sucker Conservation Fund. Certain projects funded by this account may qualify for matching grants or money from NFWF or other parties. Benefits anticipated from actions funded by the Sucker Conservation Fund are described below under “Effects of the Sucker Conservation Strategy.”

Extended Funding of the Williamson River Delta Restoration Project

To specifically mitigate the impact of take of listed suckers during the permit term, PacifiCorp also will extend its significant funding support of TNC’s Williamson River Delta Restoration Project, which is one of the basin’s most important sucker recovery and habitat restoration actions. PacifiCorp will extend its funding for this project for the duration of the permit term, resulting in total contributions of about \$200,000, depending on the farm income. From these contributions, an average of \$4,000 per year (\$40,000 over the permit term) will be used directly to implement additional projects to increase sucker habitat through riparian and wetland plantings along the Williamson River and the shoreline of Upper Klamath Lake, as well as to provide other sucker habitat enhancement projects at the Williamson River Delta Restoration project. The remainder of funds will be used for supporting ongoing sucker recovery and land management actions by TNC at the restoration project, such as creating and maintaining wetlands that improve water quality and providing rearing habitat for larval and juvenile suckers. Activities funded by PacifiCorp are expected to directly or indirectly improve survival of listed suckers and increase the likelihood of recruitment to the adult population.

These contributions will provide the support needed to continue to realize the conservation benefits of the Williamson River Delta Restoration Project (described below), for which PacifiCorp has already provided significant funding as mitigation for Project operations. This funding will provide benefits to listed suckers and contribute to meeting the goals and objectives defined in the revised sucker recovery plan (USFWS 2013), while minimizing the effect of take during the permit term.

2.4.3 Planning and Selection of Measures

Sucker Conservation Fund

Funding to support sucker recovery initiatives undertaken through the Sucker Conservation Fund will be handled initially by NFWF. In evaluating proposed sucker recovery initiatives for

¹ NFWF is a 501(c)(3) non-profit organization created by Congress in 1984. NFWF directs public conservation dollars to projects and activities that preserve and restore native wildlife species and habitats, and matches those investments with private funds. NFWF works with a variety of individuals, foundations, government agencies, nonprofits, and corporations to identify and fund important conservation projects and activities throughout the U.S.

selection and implementation, PacifiCorp and the Service will consider the goals and objectives in the revised sucker recovery plan (USFWS 2013a) and the following guidelines:

1. Whether the proposed project substantially reduces the threats to suckers, and how the project reduces these threats;
2. The recovery objectives of the proposed project and the anticipated dates for achieving them;
3. The estimated costs to complete the proposed project, along with a description of construction and permitting requirements, and the ability of the party undertaking the project to successfully and safely complete the project;
4. Whether the proposed project incorporates quantifiable, scientifically valid standards that will demonstrate achievement of recovery objectives;
5. Whether the proposed project includes provisions for monitoring and reporting progress on project implementation and effectiveness; and
6. The extent to which the proposed project is consistent with the sucker recovery plan or other pertinent scientific literature.

Williamson River Delta Restoration Project

As described above, PacifiCorp, in partnership with TNC, will continue contributing to the restoration of riparian and wetland habitats in the Williamson River Delta on Upper Klamath Lake to assist in the recovery of listed suckers over the permit term. PacifiCorp leases 1,100 acres of farmland known as “Tulana Farms” from TNC at the Conservancy’s Williamson River Delta Preserve and uses its share of the income from the property to contribute to funding restoration actions at Williamson River Delta. In October 2007, approximately 600 acres of this farmland was returned to wetlands, and the current farm operation is approximately 500 acres in area.

In 2006, after several successful pilot projects and the completion of environmental planning documents, TNC and Federal partners, including the Service, implemented a \$9 million effort to restore 5,500 acres of wetlands at the Williamson River Delta by removing approximately 2 million cubic yards of material from 22 miles of levees (Erdman and Hendrixson 2009). In support of this project, PacifiCorp voluntarily contributed \$1.6 million towards the purchase of the Williamson River delta property in 1996, provided \$750,000 in funding towards the restoration effort, and dedicated \$100,000 from its share of the 2006 and 2007 farm lease income. This \$100,000 contribution also fulfilled the requirement of a private match that helped TNC successfully compete for a \$1 million grant from the North American Wetlands Conservation Council for this restoration work. This phase of the restoration project, one of the most significant projects initiated to restore habitat and advance the recovery of the endangered Lost River and shortnose suckers, was completed in October of 2008 (Erdman and Hendrixson 2009, 2010, 2011). Subsequently, PacifiCorp also contributed an additional \$67,000 from its share of farm revenue in 2007, 2008, and 2009 that was used to further extend and deepen the breaches along the lake and the river, work that was supported and guided by staff from both TNC and the Service.

Subsequently, the Applicant also contributed an additional \$97,000 from its share of Tulana Farms revenue since 2007 to support additional restoration activities that benefit listed suckers.

These contributions supported actions to further extend and deepen the breaches along the lake and the river, work that was guided by staff from both TNC and USFWS. These efforts also included preparation of plans by TNC to implement additional riparian and wetland restoration actions in the Williamson River Delta Preserve to benefit recovery of the endangered suckers.

Throughout the permit term the applicant will continue to contribute net revenue from its share of the annual farm revenue at Tulana Farms (about \$20,000 annually depending on farm revenue) to support restoration and recovery efforts for listed suckers for the duration of the permit term. Of this amount, about \$4,000 per year will be used directly for additional sucker habitat enhancement projects at the Williamson River Delta Project to restore and improve juvenile sucker rearing habitat with the remainder used to support and maintain existing restoration projects and operations at the Preserve to ensure the continued benefit of restoration projects that have been previously undertaken.

3.0 STATUS OF THE SPECIES AND CRITICAL HABITAT

In this section, we assess the range-wide condition of the SNS and the LRS (i.e., their status). We describe factors, such as life history, distribution, population sizes and trends, and evidence of resiliency and redundancy, which help determine the likelihood of both survival and recovery. In doing so, we describe how vulnerable each affected species is to extinction. This information will inform a population viability baseline against which the effects of the proposed action will be measured.

3.1 Regulatory History

The LRS and the SNS were federally-listed as endangered throughout their entire ranges on July 18, 1988 (53 FR 27130). They are also listed as endangered by the States of California (1974) and Oregon (1991). In 2007, the status of these species was reviewed by the USFWS (USFWS 2007a, b). New 5-year status reviews of the LRS and the SNS have been recently completed (USFWS 2013 b, c). A draft revision of the 1993 recovery plan for these species was published by the USFWS in 2011, and a final revised plan published in 2013 (USFWS 2013a). The USFWS proposed critical habitat for the LRS and the SNS on December 1, 1994 (59 FR 61744), but the proposal was not finalized. On December 7, 2011, a revised proposal was published that included critical habitat in Klamath and Lake Counties, Oregon, and Modoc County, California (76 FR 76337). The final designation of critical habitat for the LRS and the SNS was published on December 11, 2012 (77 FR 73740).

3.2 Reasons for Listing

Although not explicitly stated in the final listing rule, the LRS and the SNS were listed because of the loss of populations of both species, a decline in numbers within both species' populations, and loss of habitat, all of which resulted in a critical lack of resiliency and redundancy for each species (USFWS 2013a, b, c). In this context, resiliency is the ability of a population or species to rebound after stressful environmental conditions, such as adverse water quality, increased predation, disease, drought, or climate change. Redundancy, in this context, involves multiple

populations spread over the landscape to reduce the likelihood of simultaneous extirpation from catastrophic events, such as adverse water quality, drought, or disease.

Of the few populations of the LRS and the SNS that remain, most are very restricted in distribution and many of them lack the ability to successfully reproduce. This condition was caused by several factors, including habitat loss, construction of barriers, overharvesting of adults, and entrainment of young individuals.

Suitable habitat for the LRS and the SNS was substantially reduced in extent and functionality due to the historical conversion of wetlands to agricultural use and the construction of irrigation and hydroelectric facilities, all of which drained lakes and wetlands, created barriers to spawning habitat, and caused mortality by entraining fish. Chiloquin Dam on the Sprague River was cited as the most influential barrier to sucker passage at the time of listing because it blocked access to approximately 95 percent of potential river spawning habitat for UKL populations of the LRS and the SNS (53 FR 274130). The dam was removed in 2008. Nevertheless, many other physical barriers persist throughout the range of these species, limiting the ability of populations to reproduce or disperse, such as the Tule Lake populations (NRC 2004).

Overharvesting of adult LRS and SNS potentially contributed to declining population levels in UKL, especially for the LRS, but harvest has not been authorized since 1987 (USFWS 2007a, b). Entrainment of larval and juvenile suckers into irrigation and hydroelectric structures was also cited as a threat at listing, and this loss of young fish continues to threaten these species even though several major improvements to key structures (e.g., the A-Canal fish screen) have been implemented.

Nonnative fishes were identified as a potential threat to the LRS and the SNS at the time of their listing because of potential competition and predation. In the last century, the Upper Klamath Basin has been invaded by about 20 non-native fish species (Logan and Markle 1993; Moyle 2002). Most of these species are not particularly common in the basin, but some are abundant and widespread and their effects on listed suckers are poorly understood.

Non-native fishes can have complex interactions with native fishes, and their relative impact can depend on the presence or absence of altered habitats such as impoundments and on the availability of smaller-scale habitat structure such as substrates (Markle and Dunsmoor 2007). In highly modified habitats like Lost River, Klamath River, and Klamath River reservoirs, non-native fish appear to be dominant and have a greater negative impact on endangered suckers (Koch and Contreras 1973, Shively et al. 2000, Moyle 2002, Desjardins and Markle 2000). Many of the non-native fish species are more tolerant of habitat degradation and occupy a wider range of habitats than the suckers (Moyle 2002). The degraded habitats have resulted in less shoreline vegetation that provided suckers protection from predation by non-native fish (Markle and Dunsmoor 2007, NRC 2004).

Competition for resources and predation by non-native fish on suckers in UKL is likely but difficult to quantify. Non-native fishes are the most abundant both numerically and by biomass in UKL (Scoppettone and Vinyard 1991; Logan and Markle 1993; Simon and Markle 1997, 2001). Markle and Dunsmoor (2007) were able to demonstrate predation by fathead minnow

adults on larval suckers in a controlled environment. Their research also showed that as water depth increases, the surface orientation of the sucker larvae and the bottom orientation of the fathead minnows result in enough separation to almost eliminate predation. The shoreline abundance of adult fathead minnows had a negative relationship with annual larval sucker survival, which was consistent with the density relationship found in laboratory studies. There appears to be a positive relationship between June lake level and larval sucker survival likely due to greater inundation of emergent vegetation habitat and reduced interactions with fathead minnows and other non-native predators. Fathead minnows also appear to benefit from low summer lake levels (Markle and Dunsmoor 2007). Juvenile suckers may be displaced from near-shore areas by competition for food and space by high summer densities of non-native fish particularly fathead minnows and yellow perch. Foott and Stone (2005) surmise that competition with non-native fish and other factors could contribute to an overall loss of body condition and fitness going into fall and winter and may leave juvenile suckers without adequate energy stores to survive their first winter, more vulnerable to opportunistic infections, or more sensitive to changing environmental conditions, but this is unconfirmed.

Lastly, mass mortality events in UKL are not new, but it is believed that *Aphanizomenon flos-aquae* (AFA), a nitrogen-fixing blue-green alga or “cyanobacterium,” has increasingly dominated the system, which has increased the frequency of extreme fish die-off events (NRC 2004). Although conditions are most severe in UKL and Keno Reservoir, listed suckers throughout the Klamath Basin are vulnerable to water quality-related mortality (USFWS 2007a, b, 2008, 2012, 2013a, b, c; NMFS and USFWS 2013).

3.3 New Threats

Climate Change

Since the 1950s, western North America has experienced changes in the timing and amount of precipitation, including decreased snowfall, earlier snowmelt, and earlier peak spring runoff, which appear inconsistent with historically normal fluctuations, suggesting effects from anthropogenic sources (Hamlet et al. 2005, Stewart et al. 2005, Knowles et al. 2006). Climate models indicate that these trends are likely to continue (Barnett et al. 2008). In the upper Klamath Basin, 8 of the 10 lowest total annual inflows into UKL in the past 50 years occurred between 1991 and 2009, and over the past decade, inflows to the lake have been about 9 percent less than over the previous 31 years. Additionally, the July through September inflows to UKL have declined by over 50 percent during the past 50 years (Mayer and Naman 2011).

The LRS and the SNS evolved in a region with highly variable precipitation, often with extended and severe droughts (Negrini 2002); however, given the current lack of recruitment into the adult population of each species, the absence of population connectivity (even in wet years), poor habitat conditions, and diminished abundance, LRS and SNS populations are highly vulnerable to negative impacts from climate change, especially increased drought. Threats from climate change not only include reduction in amounts of spring runoff and its timing, but are likely to also result in increasingly reduced water quantity, the spread of disease and parasites, and proliferation of invasive and nonnative species that could prey on or compete with suckers. Effects of climate change on upper basin aquatic systems are discussed in more detail below.

Disease, Predation, and Parasitism

Emerging information suggests that other natural factors may also be adversely affecting the suckers more than previously thought. For example, fish-eating birds, such as the American white pelican (*Pelecanus erythrorhynchus*), could have substantial negative impacts on adult sucker populations, especially those in Clear Lake where they could be exposed to pelican predation during the spawning migration in Willow Creek. Early data indicate that American white pelican predation rates on sub-adult or adult suckers in Clear Lake Reservoir may be as high as 20 percent in some years; however, additional research is needed to clarify the magnitude of this threat (Roby and Collis 2011, D. Hewitt, USGS, pers. comm. 2012).

Recently identified threats include algal toxins, which may have affected nearly 50 percent of 47 juvenile LRS assayed from UKL (Vanderkooi et al. 2010); parasites, including trematode flatworms (Simon et al. 2012, Markle et al. 2013), anchor worm (*Lernaea cyprinacea*), a parasitic copepod (Simon et al. 2012), and *Trichodina* sp., an external ciliate protozoan; and the bacterium *Flavobacterium columnare*, which causes gill rot (Holt 1997, Foott 2004, Foott et al. 2010). Additionally, there is new information concerning the bacterial flora on the skin of juvenile suckers (Burdick et al. 2009), but it is unknown how these bacteria affect the fish.

The LRS and the SNS are known to have at least two groups of multicellular, invertebrate parasites: *Lernaea* and digenetic trematode fluke. Trematodes are internal parasites. One of the most common trematode flukes on suckers causes what is called “black-spot disease.” In the past, the black-spot disease was thought to be caused by flukes in genus *Neascus*, a catch-all term for a group of flukes causing similar infections in fish (Kirse 2010). The larval trematodes burrow under the skin of the fish, resulting in a black cyst. The *Neascus* life cycle progresses through snails, then fish, and finally a fish-eating bird, all of which are seasonally numerous in water bodies throughout the upper basin, e.g., UKL, Keno Reservoir, Tule Lake, and the Lost River. Recently, the trematode causing black-spot disease has been identified as belonging to the genus *Bolbophorus* (D. Markle, OSU, pers. comm. 2013). *Bolbophorus* is known to cause high mortality rates in captive catfish in the Southeast (Terhune et al. 2003). The life cycle of *Bolbophorus* is believed to involve a snail and a definitive bird host which likely is the American white pelican. Additionally, juvenile suckers have been recently found to be parasitized by trematode heart worms in the genus *Ichthyocotylurus* (Simon et al. 2013, D. Markle, OSU, pers. comm. 2013).

Parasitic infections can cause physiological stress, blood loss, decreased growth rates, reduced swimming performance, lower overwinter fitness, and mortality, especially in small fish (Marcogliese 2004, Kirse 2010, Ferguson et al. 2011). In some instances, parasites can also make hosts more vulnerable to predators by affecting their morphology and/or behavior (Marcogliese 2004). Limited evidence is beginning to emerge concerning the effects of these parasites on listed Klamath suckers, showing that parasites are likely an important source of mortality for age-0 SNS (Markle et al. 2013). Markle et al. (2013) recently estimated that there was a 3.7 percent daily increase in mortality for juvenile SNS that were infected with *Neascus* like trematodes in UKL compared to uninfected fish.

3.4 Life History

The LRS and the SNS are adapted to lake environments (USFWS 2013 a, b, c). The LRS is the only extant member of the genus *Deltistes* (Miller and Smith 1967), and the SNS is one of three recognized species in the genus *Chasmistes* (Moyle 2002). Both species are relatively large, with a maximum size between 24 to 31 inches (61 and 80 cm). The LRS and the SNS feed on zooplankton and small benthic invertebrates taken from or near soft substrates (Scoppettone and Vinyard 1991).

Both species spawn from February through May over rocky substrates in habitats less than 4 feet (1.2 m) deep in rivers and at shoreline springs (Buettner and Scoppettone 1990). In UKL, it appears that more than 95 percent of adults spawn every year (Hewitt et al. 2012). Females are highly fecund, producing from 44,000 to over 200,000 eggs per LRS female and 18,000 to 72,000 per SNS female per year, of which only a very small percentage survive to become juveniles (NRC 2004). Females typically broadcast their eggs in the company of two males (Buettner and Scoppettone 1990), and the fertilized eggs settle within the top few inches of the substrate until hatching one week later.

Approximately 10 days after hatching, larvae emerge out of the substrate (Buettner and Scoppettone 1990). Most larvae spawned in streams quickly drift downstream into lake habitat (Cooperman and Markle 2004). Larval movement away from the spawning grounds begins in April and is typically completed by mid-July (Klamath Tribes 1996, Tyler et al. 2004, Ellsworth et al. 2010). Older literature concludes that SNS larvae predominantly use nearshore areas adjacent to and within emergent vegetation (Klamath Tribes 1996, Cooperman and Markle 2004, Crandall et al. 2008), and LRS larvae tend to occur more often in open water habitat (Burdick and Brown 2010) than near vegetated areas. However, Simon et al. (2013) argue that although densities of some size classes of larvae and age-0 juveniles is highest nearshore, total numbers are greatest offshore. They suggest that early SNS larvae are mostly found offshore and move inshore once they reach 16-20 mm, while LRS larvae are mostly found offshore regardless of their size. Simon et al. (2013) point out that nearshore areas are likely to have higher densities of predators and parasites. However, other factors, such as amount of cover, abundance of food, and reduced advection from the lake, might make survival rates in nearshore areas higher than in offshore areas. Nevertheless, further studies are needed before comparisons of survival rates of sucker larvae in different habitats can be made.

Sucker larvae transform into age-0 juveniles at about 1 inch (less than 3 cm) total length by mid-July. Age-0 SNS juveniles, which are individuals younger than 1 year, primarily use relatively shallow (<4 feet) vegetated areas, but may also begin to move into deeper, un-vegetated offshore habitats before the end of their first year (Terwilliger et al. 2004). Age-0 LRS juveniles tend to be mostly often caught offshore (Simon et al. 2012). Little is known about the ecology of older juvenile suckers (ages 1–4). SNS and LRS juveniles begin recruiting into the adult population at 4 to 7 years of age; LRS reach sexual maturity more slowly than SNS, and females of both species reach sexual maturity more slowly than males (Buettner and Scoppettone 1990, Perkins et al. 2000a).

Adult LRS and SNS inhabit lake environments with water depths of 3 to 15 feet (1 to 5 m), but appear to prefer depths from 5 to 11 feet (Peck 2000, Reiser et al. 2001), with LRS typically inhabiting slightly deeper habitats than SNS (Banish et al. 2009). Adult LRS and SNS in UKL

primarily occur in the northern half of UKL during the summer (Peck 2000, Banish et al. 2009), but become concentrated near and within Pelican Bay when water quality is adverse in the remainder of the lake (Perkins et al. 2000b, Banish et al. 2009). In the spring, congregations also form near tributaries or shoreline areas prior to spawning (Janney et al. 2008).

The LRS and the SNS exhibit many adaptations characteristic of long-lived species. Juveniles grow rapidly until reaching sexual maturity. Under favorable conditions, adults can have high survival rates, which enable populations to outlive adverse periods, such as droughts. Once achieving sexual maturity, LRS live an average of 12.5 years under current conditions in UKL (D. Hewitt, USGS, pers. comm. 2010). Similarly, SNS adults are estimated to live an average of 7.4 years after joining the adult population. Thus, for those individuals that survive to adulthood, we expect an average total life span of 20 years for the LRS and 12 years for the SNS, based on the average time to maturity and average adult life spans; maximum ages are up to 57 for LRS and 33 years for SNS (Scoppettone 1988, Buettner and Scoppettone 1990, Terwilliger et al. 2010).

3.5 Range-wide Distribution

The LRS and the SNS are endemic to the upper Klamath River Basin, including the Lost River and Lower Klamath sub-basins (Moyle 2002; USFWS 2013 a, b, c; Figure 3.1). Populations of both species currently exist in UKL, its tributaries, and downstream in the Klamath River reservoirs; SNS dominates in Keno Reservoir and the hydropower reservoirs in the Klamath River (Desjardins and Markle 2000, Kyger and Wilkens 2012a). Both species also occur in Tule Lake, Clear Lake, and the Lost River. Only the SNS occurs in Gerber Reservoir, but genetic evidence appears to show this population appear is intercrossed with the Klamath largescale sucker (*Catostomus snyderi*, KLS; Tranah and May 2006).

Prior to listing, populations of the LRS were extirpated from Lower Klamath Lake (including Sheepy Lake; Coots 1965) and a population of the SNS was extirpated from Lake of the Woods (Andreasen 1975). Subpopulations of the LRS or the SNS that were spawning at Barkley Springs, Harriman Springs, other springs, and smaller tributaries to UKL have also been extirpated (USFWS 2013a, b, c). Other than populations in UKL, Clear Lake, and Gerber Reservoir, all other populations of both species are believed to be population sinks, populations that result from dispersal from a producing population but cannot maintain themselves through larval production. Suckers are suspected by some to spawn in the Link River (Smith and Tinniswood 2007), the Lost River below Anderson-Rose Dam (Hodge and Buettner 2009), in the upper reach of Copco Reservoir (Beak Consultants Incorporated 1988), and above Malone Dam (Sutton and Morris 2005); however, due to small numbers, the lack of suitable habitat, and presence of numerous predators, these attempts likely do not lead to recruitment into the adult populations (USFWS 2013a, b, c).

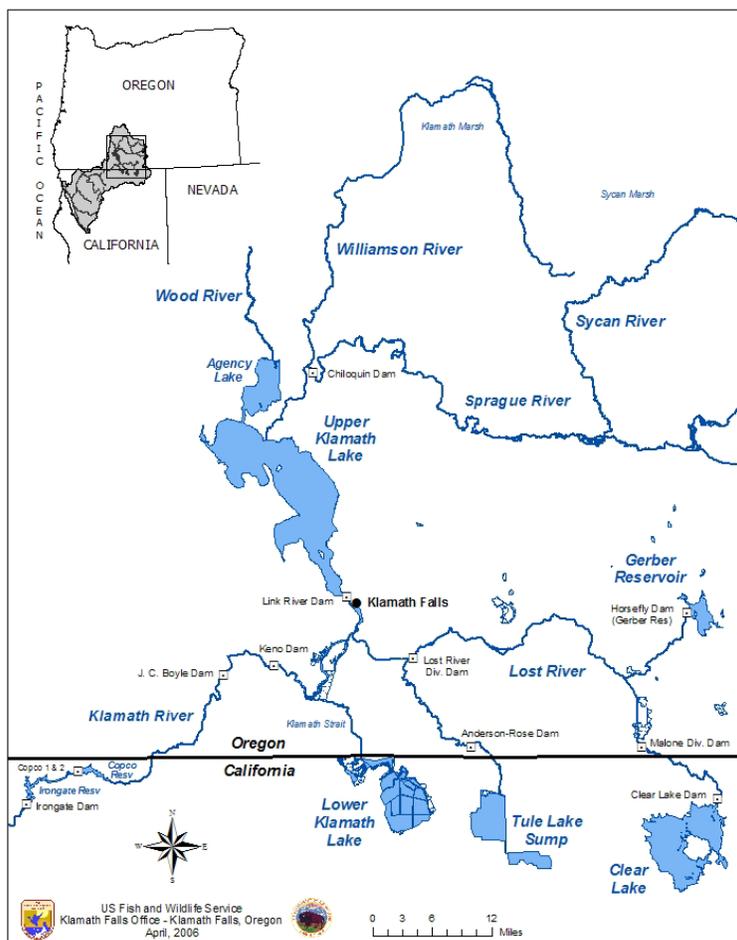


Figure 3.1. The LRS and the SNS currently occur in UKL, reservoirs along the Klamath River, Clear Lake, Tule Lake, and the Lost River; the SNS is also found in Gerber Reservoir. Adult suckers use the major tributaries such as the Sprague, Williamson, and Wood Rivers for spawning.

3.6 Genetics

In an assessment of mitochondrial DNA (mtDNA), Dowling (2005) reported that the LRS is relatively distinct genetically from the other sucker species in the Klamath Basin (USFWS 2013b). Similarly, microsatellite markers indicate that LRS do not regularly interbreed with the other catostomids in the Klamath Basin (Tranah and May 2006). In addition, differences in mtDNA of LRS populations in the upper Klamath Basin compared to those in the Lost River sub-basin suggest that these should be treated as separate LRS units (Dowling 2005).

Conversely, little distinction between SNS and KLS mtDNA and microsatellite markers has been found (Dowling 2005, Tranah and May 2006, USFWS 2013c), suggesting that interbreeding has occurred in the past and likely continues to occur between these species. This is especially true in the Lost River sub-basin, but morphological, behavioral, and ecological distinctions are maintained in most populations (Markle et al. 2005). Increased hybridization resulting from human intervention can be cause for concern for imperiled species, and may even lead to

extinction (Rhymer and Simberloff 1996). However, data suggest that intercrossing among Klamath Basin suckers is consistent with a pattern of historical intercrossing, which is not uncommon for fish in the sucker family *Catostomidae* (Dowling and Secor 1997, Dowling 2005, Tranah and May 2006). Further studies are needed to determine the extent, causes, and effects of this intercrossing, but based on the historical pattern of intercrossing of these species and the fact that many individuals retain much of the SNS phenotype we consider these SNS to be protected under the ESA. A genetic distinction among SNS populations between basins is weakly defined. Currently, there is no opportunity for upstream gene flow between the populations of both species because of many significant physical barriers (USFWS 2013a).

3.7 Range-wide Population Trends

Starting in the late 1800s, large areas of sucker habitat were converted to agriculture and barriers were created that isolated populations from spawning grounds (USFWS 2012). Although there are no survey records until the 1900s, these once superabundant species likely began to decline in numbers around the turn of the 20th century concurrent with significant destruction and degradation of aquatic and upland habitats. Later, from the 1960s to the early 1980s, recreational harvests of suckers in UKL progressively decreased (Markle and Cooperman 2002), which reflected further declines in the LRS and SNS populations and led to their listing under the ESA in 1988. From 1995 to 1997, water quality-related die-offs killed thousands of adult suckers in UKL (Perkins et al. 2000). Over that three-year period, more than 7,000 dead suckers were collected and many other dead suckers were likely present but not detected.

More recently (between 2002 and 2010), the abundance of LRS males in the lakeshore-spawning subpopulation in UKL decreased by 50 to 60 percent, and the abundance of females in UKL decreased by 29 to 44 percent (Hewitt et al. 2012; Figure 3.2). It is not clear if the river-spawning subpopulation of the LRS in UKL increased or decreased between 2002 and 2010 because of improvements in sampling methodology partway through the study that gave the appearance of a large influx of individuals; however, this population likely decreased proportionately with the spring-spawning population (Hewitt et al. 2012).

Capture-recapture data indicate that the UKL SNS adult population decreased in abundance by 64 to 82 percent for males and 62 to 76 percent for females between 2001 and 2010 (Hewitt et al. 2012). Although the adult populations of both species in UKL have declined substantially, the SNS adult population is at a greater risk of extirpation from UKL than LRS because it declined to a greater degree and LRS are approximately 10 times more numerous than SNS in UKL (Hewitt et al. 2012). If the trend from 2001 through 2010 continues for the SNS in UKL we may expect that roughly 1,000 individuals will remain by the end of the term of the BO. However, the risk of extirpation becomes even more likely given the relatively advanced age of most individuals in UKL, which will likely worsen the declining trends during the next 10 years as individuals begin to succumb to old age (USFWS 2013a, b, c).

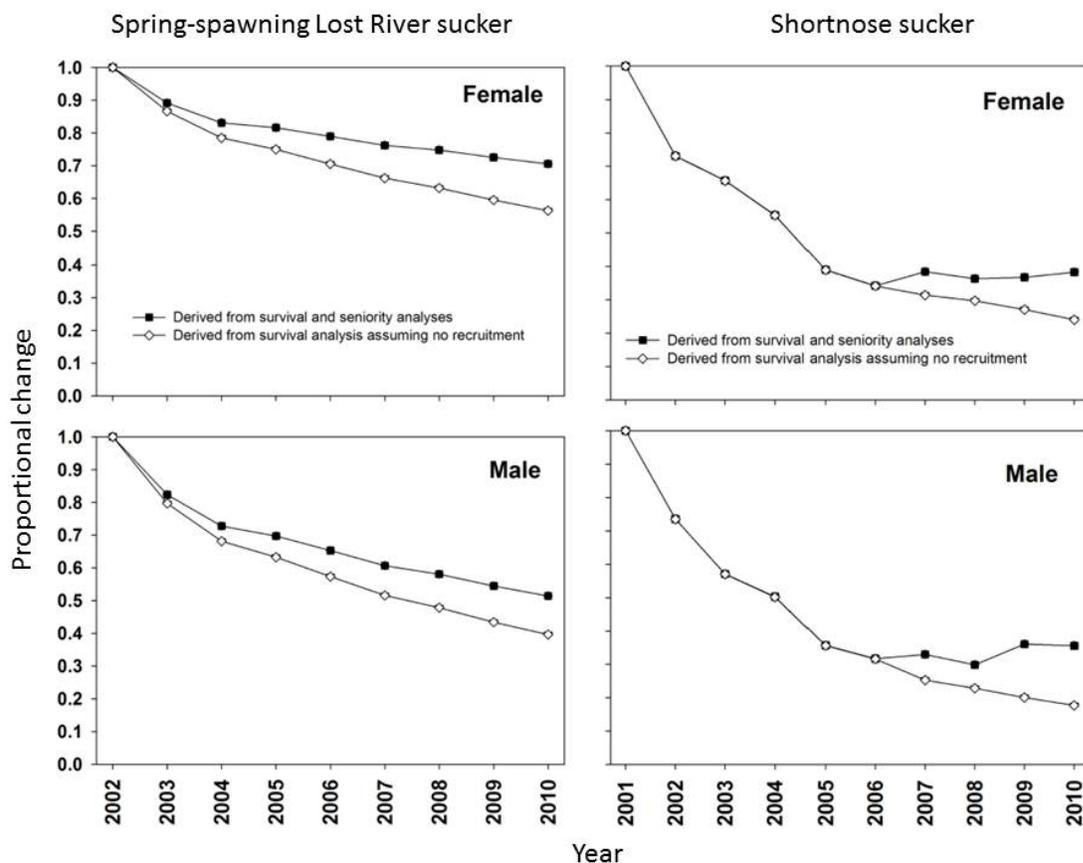


Figure 3.2. Graphs showing declines in adult sucker populations in UKL from 2002 to 2010, as estimated by two mark-recapture models in program MARK (figures taken from Hewitt et al. 2012).

Recent LRS and SNS size distribution trends reveal that the adult spawning populations within UKL are comprised mostly of similarly-aged, relatively old individuals (USFWS 2013a, b, c). Since the late 1990s, median lengths of populations have increased by approximately 0.16 inches (4 millimeters [mm]) per year for the SNS and 0.4 to 0.5 inches (9 to 12 mm) per year for the LRS (Hewitt et al. 2012). If younger individuals (which are typically smaller) were frequently joining the population the median length would remain stable, suggesting that recruitment of new adults is minimal to nonexistent. Most adult suckers currently in UKL are believed to be the result of spawning that occurred in the early 1990s (Janney et al. 2008). These fish are now approximately 20 years of age, and are well beyond the average life span of 12 years for the SNS and equal to that of 20 years for the LRS. Even though viable eggs and larvae are produced each year, few of these fish are reaching adulthood, and many existing adults will likely not contribute reproductively for many more years. This trend is especially untenable for the SNS, and without substantial recruitment in the next decade, the population will be so small that it is unlikely to persist (USFWS 2013c).

Insufficient monitoring data are available to determine trends for other LRS and SNS populations, but since the populations in UKL are the source of most of the LRS and SNS populations elsewhere, we expect the trends in those populations to be similar to those in UKL.

Loss of the UKL LRS and SNS populations would put both species at a high risk of extinction because the UKL populations represent approximately 40 to 80 percent of the total range-wide population of the SNS and the LRS, respectively (Table 3.2). Loss of the UKL populations would reduce the number of self-sustaining populations from two to one for the LRS, and from three to two for the SNS. If these losses occurred, it would significantly reduce both the resiliency and the redundancy of the LRS and SNS populations range-wide. Resiliency and redundancy are crucial for survival and recovery of these species (USFWS 2013a, b, c).

3.8 Range-wide Population Dynamics

Adult Population Sizes

Because of the wide-ranging behavior, expansive habitat, and rarity of the LRS and the SNS, obtaining accurate population estimates is impracticable. However, long-term monitoring using capture-recapture methods provide accurate information on relative changes in abundance (Hewitt et al. 2012). For example, in 2011, UKL monitoring detected or captured approximately 22,000 tagged LRS (Hewitt et al. 2012). Approximately 37 percent of these individuals were spawning at the springs along the eastern shoreline of the lake. The proportion of tagged individuals in the total UKL population is unknown. If that were known, it would allow for the calculation of a relatively accurate estimate of overall numbers in UKL. However, the proportions of tagged to untagged individuals in direct captures suggest that the LRS population in UKL likely numbers between 50,000 and 100,000 adults (Hewitt et al. 2012). The number of adult SNS in UKL is likely to be fewer than 25,000, given that only approximately 10,000 individual SNS were captured or otherwise detected during the 2011 spawning season (Hewitt et al. 2012).

In Clear Lake, SNS are more abundant than LRS. Approximately 2,500 tagged SNS were detected during the spawning run up Willow Creek in 2011 (B. Hayes, USGS, pers. comm. 2011); slightly less than 500 tagged LRS were detected during the same period at this location. Although reliable estimates of total population numbers are unavailable, data suggest that fewer than 25,000 adult SNS and fewer than 10,000 adult LRS occur in Clear Lake.

Data on LRS and SNS populations in Keno Reservoir, Klamath River reservoirs, Tule Lake, Gerber Reservoir, and the Lost River are limited, but the monitoring efforts completed for these populations indicate low numbers of each species, with perhaps fewer than 5,000 individuals total for the LRS and the SNS in Tule Lake (Hodge and Buettner 2009), Keno Reservoir (Kyger and Wilkens 2010), and the Klamath River reservoirs below Keno (Desjardins and Markle 2000). In 2010, 413 suckers (187 LRS, 227 SNS, and 3 unknowns) were captured in Tule Lake and relocated to UKL (Courter et al. 2010). SNS dominates in the Keno Reservoir and downstream in the hydropower reservoirs (Desjardins and Markle 2000, Kyger and Wilkens 2012b). The Gerber Reservoir SNS population is estimated to be less than 5,000 (Table 3.3).. The approximate size of known SNS and LRS populations are shown in Table 3.3 below. Based on limited data, we estimate that the approximate total range-wide adult population is 65,000 to 115,000 individuals for the LRS and less than 60,000 individuals for the SNS.

Table 3.3. Estimated LRS and SNS adult sucker population sizes. Note: The estimate for UKL is based on Hewitt et al. (2012). Clear Lake and Gerber Reservoir contain self-sustaining sucker populations. The “Other Areas” locations include Keno Reservoir, Tule Lake, Lost River, and four Klamath River reservoirs downstream of Keno that are considered to contain sink populations. Source: NMFS and USFWS (2013).

Location	No. of Adult LRS	No. of Adult SNS
UKL	50,000-100,000	<25,000
Clear Lake	<10,000	<25,000
Gerber Reservoir	None	<5,000
Other Areas	<5,000	<5,000

LRS and SNS Population Demographics

Survival and recruitment rates of SNS and LRS adults in UKL have varied little over the past decade (USFWS 2013a, b, c). Annual adult survival rates of the SNS in UKL appear to vary more than the LRS, but adults of both species in UKL appear to be relatively stable (Hewitt et al. 2012), excluding years of large fish die-offs as in 1995, 1996, and 1997. Modeling of LRS and SNS adult populations since 2001 suggests a low rate of recruitment (Hewitt et al. 2012), which has resulted in adult populations for both species that are homogenous in size and age. If this lack of recruitment continues, it will cause instability and eventually lead to extirpation of these species from UKL. Biologists generally accept that the last substantial recruitment for both the LRS and the SNS in UKL occurred in the late 1990s, from fish that were spawned earlier in the decade (e.g., 1991). Although it is difficult to verify this finding using standard fish-ageing techniques (given the long life of these species, annual growth rings are often difficult to differentiate), the size distribution of spawning adults appears to corroborate this view. Between 2000 and 2011, the length distribution of both species in UKL steadily shifted upwards, with few smaller (and presumably younger) individuals being present (Hewitt et al. 2012).

Given the scarcity of juvenile suckers in UKL and the time it takes for these species to become sexually mature, it likely will be at least 4 years before substantial recruitment into the adult age class occurs because there are no known cohorts in the queue. Although we do not know specifically how this current uniform age distribution compares to historical conditions, healthy adult populations of long-lived species should generally possess multiple reproducing year-classes (USFWS 2013a).

In Clear Lake, survival and recruitment rates of SNS appear to be fairly consistent, given the normal distribution of size classes of captured individuals since 2004 (Hewitt and Janney 2011; based on the assumption that size is generally related to age). During the same period, annual size distribution surveys indicated a group of sub-adult LRS was progressing towards sexual maturity, but this cohort inexplicably disappeared from samples taken in 2008 (E. Janney, USGS, pers. comm. 2011).

3.9 Summary of Range-wide Status

The status of the LRS and the SNS has declined since listing. The SNS is especially vulnerable because of substantial population declines in UKL and relatively small populations overall.

Adverse water quality in UKL in the 1990s caused massive die-offs of both the LRS and the SNS. Since 2001, SNS in UKL have declined by as much as 70 to 80 percent and LRS in UKL have declined by as much as 40 to 60 percent, suggesting a lack of resiliency. SNS in UKL are also vulnerable because most are well past their average life expectancy, and LRS are at their average life expectancy, thus the rate of decline could increase if there is not substantial recruitment into the adult age class. However, recruitment of both species into the adult population in UKL in the past decade has been nearly nonexistent, and there is no evidence of large cohorts of young suckers that could enter the adult population in the next few years. Loss of the UKL populations would leave only one self-sustaining population of the LRS and two self-sustaining populations of the SNS; thus, there is little redundancy for either species, adding to their risk of extinction. Given this information, the Service finds that LRS and SNS populations, especially the SNS population in UKL, are at a high risk of extinction.

3.10 Recovery Units

The revised recovery plan for the LRS and the SNS identifies recovery units for both of these species, based on the limited information on genetic and ecological distinction between sub-basins (USFWS 2013a, b. c). The UKL Recovery Unit is subdivided into four management units: (1) UKL river-spawning individuals; (2) UKL spring-spawning individuals (LRS only); (3) the Keno Reservoir Unit, including the area from Link River Dam to Keno Dam; and (4) the reservoirs along the Klamath River downstream of Keno Dam, known as the Klamath River Management Unit. The Lost River Recovery Unit is also subdivided into four management units: (1) Clear Lake; (2) Tule Lake; (3) Gerber Reservoir (SNS only), and (4) the Lost River proper (mostly SNS). By specifying recovery units, USFWS indicates that recovery cannot occur without viable populations in each recovery unit; however, this does not mean that each management unit has equivalent conservation value or is even necessary for species recovery to be achieved. Viable populations are ones that are able to complete their life cycle regularly with recruitment into and diverse age composition in the adult population.

In the revised recovery plan for the LRS and the SNS (USFWS 2013a), the criteria to assess whether each species has been recovered are focused on reduction or elimination of threats and demographic evidence that sucker populations are healthy. The threats-based criteria for down-listing include: (1) restoring and enhancing habitats, including water quality; (2) reducing adverse effects from nonnative species; and (3) reducing losses from entrainment. To meet the population-based criteria for delisting, each species must exhibit an increase in spawning population abundances over a sufficiently long period to indicate resilience, as well as establish spawning subpopulations within UKL.

3.11 Survival and Recovery Needs

The 2013 revised recovery plan for the LRS and SNS (USFWS 2013a) describes their survival and recovery needs, which are:

- Adequate quality and quantity of habitat to support the needs of all life stages of LRS and SNS.

- Improved water quality to a level where adverse effects are not sufficient to threaten the continued persistence of the LRS and the SNS.
- Connectivity throughout the range of LRS and SNS to ensure appropriate genetic exchange among populations, to provide access to spawning and refuge areas, and to permit return of downstream migrants.
- A sufficient number of viable, self-sustaining populations of the LRS and SNS to buffer against localized extirpations.
 - Substantially reduced entrainment of larval, juvenile and adult LRS and SNS, particularly in UKL.
 - Increased frequency and magnitude of recruitment into the adult spawning populations of both the LRS and the SNS.
 - Populations of sufficient sizes to ensure genetic variability to enable LRS and SNS to respond to changing ecosystem conditions.

4.0 ENVIRONMENTAL BASELINE

ESA regulations define the environmental baseline as “...the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process” (50 CFR 402.02). The environmental baseline is an analysis of the factors that have, are, or will continue to affect listed species in the action area, not merely a recitation of the actions that have occurred or are occurring in the action area. The environmental baseline analysis will help us assess how the proposed action will affect listed species.

4.1 Status of LRS and SNS Populations in the Action Area

The following section provides a review of current condition of the species in the action area and the factors responsible for that condition.

Link River (RM 254-253). The Link River is a 1 mile-long, relatively steep reach with several cascades (“falls”) that extends from the outlet of UKL above the Link River Dam to Keno Reservoir. The streambed is mostly bedrock, and at lower flows the river breaks into smaller braided channels. The Link River Dam and East Side and West Side facilities are located on the Link River about 0.25 miles downstream from the outlet of UKL.

Water quality in the Link River is similar to that in UKL, and includes periods of high water temperatures, low DO levels, and high pH levels. All life stages of listed suckers have been found in Link River in recent years based on monitoring below UKL and the Link River Dam. This habitat is primarily a migration corridor for large numbers of larval and juvenile suckers dispersing downstream from UKL to Keno Reservoir (Gutermuth et al. 2000a, b). Juvenile suckers were consistently caught during salvage operations conducted in the upper Link River

during maintenance operations and spill termination for Link River Dam, which occurs in most seasons except the January-March period.

While juvenile suckers occupy habitat throughout the Link River in low numbers, the lower Link River is an important water quality refuge area for juvenile and adult suckers during periods of low dissolved oxygen (DO) in Keno Reservoir. Link River, because of its high gradient and numerous cascades, has a significant potential for oxygenation of water prior to entry into Keno Reservoir, where there is a high biochemical oxygen demand (BOD). Summer water quality in parts of the Keno Reservoir is frequently lethal and the better water quality in the lower Link River may allow fish from Keno Reservoir to survive (Piaskowski 2003, Deas and Vaughan 2006). In 2002 through 2004, radio-tagged adult suckers in the Keno Reservoir moved into the Link River during the summer when water quality in the reservoir degraded to particularly low DO concentrations (Piaskowski 2003, Piaskowski and Simon 2005).

Keno Reservoir (RM 253-233). Keno Reservoir (including Lake Ewauna) is actually a widened part of the head of the upper Klamath River. The reservoir is 20 miles long, has a surface area of 2,475 acres, an average depth of 7.5 feet, a maximum depth of 20 feet, and a total storage capacity of 18,500 acre-feet. Water levels in Keno Reservoir are normally maintained within a 0.5 foot range by the Keno Dam. Summer water quality is generally poor, with heavy algae growth, high temperatures, pH, un-ionized ammonia, and low DO (ODEQ 2010, Sullivan et al. 2011). For example, preliminary water quality data from the USGS for July 25, 2013, showed DO values at or less than 1 mg/L for most of the stations in the Keno Reservoir (D. Eldridge, USGS pers. comm. 2013).

Keno Reservoir is the first of five reservoirs on the Klamath River and is located just downstream of UKL, near Klamath Falls, Oregon. Fish sampling conducted by PacifiCorp in 2001 and 2002 in Keno Reservoir indicates that fish populations are very similar in species composition to those in Link River and are dominated by the same pollution-tolerant species: blue chub (*Gila coerulea*), tui chub (*Siphateles bicolor*), and fathead minnow (*Pimephales promelas*; PacifiCorp 2004). Several other fish distribution studies have been conducted in Keno Reservoir including: Hummel (1993), Oregon Department of Fish and Wildlife (ODFW 1996), Piaskowski (2003), Terwilliger et al. (2004) and Kyger and Wilkens (2010). Oregon State University (OSU) conducted a more rigorous sampling effort in 2002 through 2003 monitoring all life stages in multiple locations throughout Keno Reservoir (Terwilliger et al. 2004). Larvae and age-0 suckers were most abundant in Keno Reservoir and decreased downstream. Juvenile and adult suckers were uncommon. Most of the larvae and age-0 suckers captured by OSU likely were fish entrained from UKL, according to entrainment studies at East Side and West Side diversion canals at Link River Dam in 1998 and 1999 (Gutermuth et al. 2000a, b), and below Link River Dam in 2005 and 2006 (Tyler 2007).

Reclamation staff recently sampled adult suckers in Keno Reservoir, and based on their data it appears that sucker populations likely exceeds 1,000 and are mostly represented by SNS (Kyger and Wilkens 2010; Table 4.1). Because the adult suckers present in Keno Reservoir probably represent fish entrained from UKL, the reservoir contains what is viewed as a sink population, because water quality conditions in Keno Reservoir likely prevent year-round rearing except in the upper portion of the reservoir near Link River where water quality is adequate for fish (USFWS 2007a, 2008, 2012).

Table 4.1. Results of Reclamation’s sucker collections in Keno Reservoir in 2008-2011. Source: Kyger and Wilkens (2010).

Year	LRS	SNS	KLS	Hybrids or Unidentified	Total
2008	18	87	24	7	136
2009	83	503	56	49	691
2010	56	394	67	25	581
2011	93	151	8	2	254

Poor summertime water quality likely affects the numbers of suckers in Keno Reservoir, especially juveniles. DO levels reach stressful and lethal levels for suckers every summer, particularly during July and August (Piaskowski 2003). Also, due to past diking and draining of wetlands for agricultural purposes along the Klamath River above Keno Dam and water management operations resulting in stable water levels, very little wetland habitat is available for larval and juvenile sucker rearing. Loss of larval and juvenile suckers also occurs through entrainment at irrigation diversions that occur in this reservoir. The major diversions from the Keno Reservoir include the Lost River Diversion Channel, North Canal, and Ady Canal. Additionally, there are over 60 smaller irrigation diversions in Keno Reservoir as well as drains that enter the reservoir, including the Klamath Straits Drain coming from the Klamath Project (USBR 2001).

Mortality associated with the operation of A Canal, Link River Dam and East Side and West Side facilities reduces the number of suckers entering the reservoir. Larval and juvenile suckers dispersing downstream into Keno Reservoir are also impacted by stranding associated with down-ramping and low flows in Link River (USFWS 2007a). Large numbers of non-native fish, particularly fathead minnows, likely compete with and prey on larval and juvenile suckers in Keno Reservoir. Additionally, juvenile suckers in the Keno Reservoir are heavily parasitized by trematodes (Simon et al. 2013).

Keno Reach of the Klamath River (RM 233-228). Downstream of Keno Dam, the Klamath River flows freely through a canyon with a relatively high gradient of 50 feet/mile or about 1 percent for 4.7 miles until it enters J.C. Boyle Reservoir. The river channel is generally broad with habitat consisting of rapids, riffles, and pocket water among rubble and boulders. Water quality in the Keno reach is influenced by water quality in Keno Reservoir but has higher levels of DO resulting from the river’s turbulence creating a productive aquatic environment.

Fish sampling conducted by PacifiCorp in 2001 and 2002 indicates that few suckers are present in the Keno reach and the fish population is dominated by marbled sculpins (*Cottus klamathensis*), fathead minnows, blue chubs, speckled dace (*Rhinichthys osculus*), and tui chubs. The presence of SNS and LRS in the Keno reach likely reflects the downstream emigration of larvae, juvenile and adults from upstream habitat, a behavior suggested for those two species when present in the Klamath River below J.C. Boyle Dam (Henriksen et al. 2002). It is unlikely that LRS and SNS spawning occur in the Keno reach because of the high gradient and lack of spawning gravel. Based on the estimated number of adult listed suckers in J.C. Boyle Reservoir (several hundred individuals; USFWS 2007a), it is estimated that about 20 percent of the

populations will migrate up to the Keno Dam during the spring spawning period each year (Perkins et al. 2000a)..

J.C. Boyle Reservoir (RM 228-225). The upstream half of J.C. Boyle Reservoir is shallow and is surrounded by a low-gradient, gently sloping shoreline, while the reservoir deepens in the lower half, where the canyon narrows again. The upper end of the reservoir contains a large amount of macrophytes during the summer and several fairly large shoreline wetland areas. The reservoir is 3.6 miles long, has a surface area of 420 acres, an average depth of 8.3 feet, a maximum depth of 53 feet, and a total storage capacity of 3,500 acre-feet. Water levels in J.C. Boyle Reservoir are normally maintained within 5.5 feet of full pool, and daily fluctuations due to peaking operation of the J.C. Boyle development are typically between 1 and 2 feet. Like the upstream Keno Reservoir, water quality is often degraded, particularly during the summer (ODEQ 2010).

The fish community is dominated by chub species, fathead minnows, and bullheads (Desjardins and Markle 2000a). All four Klamath Basin sucker species have been captured in J.C. Boyle Reservoir (Desjardins and Markle 2000). SNS and Klamath smallscale suckers (*Catostomus rimitulus*) were fairly common, KLS was uncommon, and LRS was rare. Desjardins and Markle (2000) captured 44 SNS and 2 LRS sub-adult/adult suckers during 1998 and 1999. Based on a comparison of LRS and SNS catch rates and population size estimates in Keno Reservoir, we suspect there are several hundred adults suckers in J.C. Boyle Reservoir. The SNS and LRS suckers accounted for about 1.5 percent of the native fish captured in J.C. Boyle Reservoir and may represent individuals or their progeny that originated in UKL. Desjardins and Markle (2000) collected larval and juvenile suckers during 1998 and 1999 in J.C. Boyle Reservoir, but their species identity and source are unknown. Spencer Creek is the only tributary of significance to J.C. Boyle Reservoir, but no LRS or SNS have been documented spawning in Spencer Creek; however, Klamath smallscale suckers do spawn in the creek.

Listed sucker populations in J.C. Boyle Reservoir are primarily limited by the amount of rearing habitat in the impoundment and competition and predation from non-native fish including fathead minnows, yellow perch (*Perca flavescens*), bullheads (*Ameiurus* spp.), and largemouth bass (*Micropterus salmoides*) (NRC 2004). However, J.C. Boyle Reservoir contains fewer non-native fish predators than the lower two large reservoirs, Copco No. 1 and Iron Gate (Desjardins and Markle 2000). Water-level fluctuations in J.C. Boyle Reservoir, resulting from daily peaking operations at J.C. Boyle Powerhouse, may further complicate the interactions of predation and habitat availability. If water level fluctuations force larval and juvenile suckers to abandon refuge littoral areas, they can be more vulnerable to predators.

Copco No. 1 Reservoir (RM 204-199). Copco No. 1 Reservoir, or simply “Copco Reservoir”, is 4.5 miles long, has a surface area of 1,000 acres, an average depth of 34 feet, a maximum depth of 108 feet, and a total capacity of 33,724 acre-feet. The reservoir was formed when Copco No. 1 Dam was constructed in 1918. The dam is 126-feet high and does not include any fish passage facilities. Water levels in Copco No. 1 Reservoir are normally maintained within 6.5 feet of full pool, and daily fluctuations due to peaking of the J.C. Boyle and Copco No. 1 developments are typically 0.5 feet.

The reservoir is located in a canyon and is quite deep compared to the Keno and J.C. Boyle Reservoirs. It contains several coves with more gradual slopes, and large areas of thick aquatic vegetation are common in shallow areas. Nearshore riparian habitat is generally lacking, due to the cliff-like nature of the shorelines, and only very small isolated pockets of wetland vegetation exist. Water quality in the reservoir is generally degraded during the summer months, and a predictable sequence of algae blooms occur as temperatures warm, including large blooms of the nitrogen-fixing, blue-green alga, *Aphanizomenon flos-aquae*.

Fish collections by OSU in Copco No. 1 Reservoir in 1998 and 1999 were dominated by yellow perch, unidentified larval suckers, and golden shiners (*Notemigonus crysoleucas*) (Desjardins and Markle 2000). Substantial numbers of adult SNS were captured from Copco Reservoir (Beak Consultants Inc. 1987, Buettner and Scoppettone 1991, Desjardins and Markle 2000). Based on a comparison of LRS and SNS catch rates and population size estimates in Keno Reservoir, we suspect there are approximately 700 adults suckers in J.C. Boyle Reservoir. Approximately 13 percent of the adult fish collected in the OSU study were SNS. In 1998 and 1999, only three juvenile suckers (unknown species) were collected (Desjardins and Markle 2000). Thousands of sucker larvae were collected; however, species identity was not known. SNS spawn in the Klamath River just upstream of the reservoir, but a lack of suitable rearing habitat, poor water quality, and presence of numerous predatory fishes makes it unlikely that there is any recruitment result from larvae produced in the reservoir.

Copco No. 2 Reservoir (RM 198). The Copco No. 1 powerhouse discharges up to 2,962 cfs into Copco No. 2 Reservoir, which is approximately 0.25 mile in length, and was formed by the construction of the 33-foot high Copco No. 2 Dam in 1925. There are no fish passage facilities at the Copco No. 2 development, and PacifiCorp did not conduct any fishery sampling in Copco No. 2 Reservoir due to its small size. Copco No. 2 Dam diverts up to 3,300 cfs into a flow line, leading to a powerhouse at the head of Iron Gate Reservoir. Due to the small size of its reservoir, the Copco No. 2 development operates in tandem with the Copco No. 1 development. Although the existing license does not specify a ramping rate or minimum flow for the bypassed reach, PacifiCorp currently releases 5 to 10 cfs from the dam into the Copco No. 2 bypassed reach which is 1.5 miles in length. No fish monitoring has occurred in Copco No. 2 Reservoir, but the small size and high rate of water exchange probably does not allow it to support listed suckers.

Iron Gate Reservoir (RM 198-190). Iron Gate Reservoir is 6.8 miles long, has a surface area of 944 acres, an average depth of 62 feet, a maximum depth of 167 feet, and a total storage capacity of 51,000 acre-feet. It was formed when Iron Gate Dam was constructed in 1962. The 173 foot-high dam does not include any fish passage facilities. Water levels in Iron Gate Reservoir are normally maintained within 4 feet of full pool, and daily reservoir fluctuations due to peaking operation of the upstream J.C. Boyle and Copco dams are typically 0.5 feet.

Iron Gate Reservoir is similar to Copco Reservoir in that it is located in a canyon, and is large and deep with generally steep shorelines except for a few coves with more gradual slopes. Large areas of thick aquatic vegetation are common in shallow areas. Nearshore riparian habitat is generally lacking. Due to the cliff-like nature of the shorelines, only very small isolated pockets of wetland vegetation exist around the perimeter of the reservoir. Water quality in the reservoir

during the summer is generally quite poor, large blooms of cyanobacteria including *Aphanizomenon* and *Microcystis* occur, and surface water temperatures are warm.

Fish collected in Iron Gate Reservoir during OSU's 1998 and 1999 surveys were dominated by native tui chub and nonnative fishes, including golden shiners, pumpkinseed (*Lepomis gibbosus*), yellow perch, and largemouth bass (Desjardins and Markle 2000). Based on fish monitoring data since 1976, no LRS and relatively few SNS were captured in Iron Gate Reservoir (CDFG 1976, Buettner and Scopettone 1991, Desjardins and Markle 2000). Most of the adult SNS appeared to be older individuals. Because sucker catch rates are so low in Iron Gate Reservoir, it is likely that they number less than several hundred. During 1998 and 1999, no juvenile suckers were captured (Desjardins and Markle 2000). Over a thousand sucker larvae were captured in this study, but the species and their origin are unknown; however, it is likely they drifted downstream from UKL.

4.2 Summary - Status of LRS and SNS Populations in the Action Area

Information on the status of LRS and SNS in the action area from Link River Dam to Iron Gate Dam is less extensive than that for sucker populations upstream of the hydroelectric Project in UKL, Clear Lake, and Gerber Reservoir. However, investigations have been adequate to determine relative abundance and distribution of sucker populations and habitat conditions. The range of listed suckers, which prefer lakes, was expanded downstream in the Klamath River by the construction of J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate Reservoirs. Sucker populations are probably most numerous in the Keno Reservoir, where there are approximately 1,000 adults. SNS are much more abundant than LRS in all of the reservoirs downstream of the Link River Dam.

Based on entrainment studies at Link River Dam and fish distribution studies in the hydroelectric Project reservoirs, substantial numbers of larval and juvenile suckers appear to disperse downstream from UKL and reside in the Klamath River reservoirs. There is no evidence that self-reproducing LRS or SNS populations exist in any of the reservoirs. SNS spawning and larval production occurs in Copco No. 1 Reservoir, but poor summertime water quality and large populations of non-native predatory fish are likely to substantially reduce survival and prevent recruitment into the adult population. The National Research Council (2004) concluded that sucker populations in Klamath River reservoirs do not have a high priority for recovery because they are not part of the original habitat complex of the suckers and the reservoirs probably are inherently unsuitable for completion of life cycles of suckers. Nevertheless, maintenance of adult suckers in these reservoirs provides long-term storage of a small number of adult suckers for potential conservation use in the future and ensures against loss of other subpopulations, if needed.

4.3 Factors Affecting the Species Environment in the Action Area

As stated above, the action area is the Link River and Klamath River, from the Link River Dam (RM 254) downstream to Iron Gate Dam (RM 190). The main factors affecting the species environment in the action area include: turbine and spillway mortality and entrainment into Klamath Hydroelectric Project facilities, entrainment into agricultural diversions, non-native fish

interactions, habitat loss and degradation, and poor water quality (USFWS 2007a, 2008). Of these factors, water quality is believed to be the major threat, especially in the Keno Reservoir; however, entrainment is the largest quantified loss of suckers in the action area (USFWS 2008). In the Keno Reservoir these two factors work in concert because entrainment causes sucker to enter the reservoir where habitat conditions, including water quality, are so poor that most suckers likely die (USFWS 2007a, 2008). Threats to suckers in the action area are described in detail below with emphasis on the impacts of PacifiCorp's hydroelectric project. Most of this information was previously covered in the 2007 FERC BO (USFWS 2007a) and more recently in the Environmental Impact Statement and associated BO on the Klamath facilities removal, also known as the "Klamath Basin Restoration Agreement," or "KBRA" (USDOJ and CDFG 2013). Effects of Reclamation's Klamath Project on the listed suckers were recently consulted on (NMFS and USFWS 2013).

4.3.1 Effects to LRS and SNS from Link River Dam and Klamath River Hydroelectric Facilities

Dams, especially hydroelectric dams, can have a variety of adverse effects on native fishes, including entrainment into turbines and spillways, ramp rate effects, water-level fluctuations, dewatered channels, blocked passage, alterations in natural flows, geomorphic habitat changes, degraded water quality, and habitat for exotic species (Collier et al. 1996). However, dams also create lake habitats where none existed before, which may benefit species that can survive in reservoirs. This has allowed Klamath Basin suckers, especially the shortnose sucker, to extend their range downstream below Keno (Desjardins and Markle 2000).

Entrainment of LRS and SNS at the Outlet of UKL

Suckers of all life-stages are entrained at the Link River Dam, and larval suckers are entrained at the A Canal, both located at the outlet of UKL. The effects of entrainment on LRS and SNS have been described in previous consultations, most recently in 2013 (NMFS and USFWS 2013). Because that topic has been covered recently, we incorporate that information by reference. Entrainment causes the largest quantified loss of LRS and SNS and is estimated to involve millions of larvae and tens of thousands of juveniles annually (Gutermuth et al. 2000a, b; USFWS 2008; NMFS and USFWS 2013).

Entrainment of planktonic sucker larvae in UKL is thought to be related to drift and wind-driven circulation patterns (USFWS 2008), but entrainment of juvenile suckers that are more bottom-oriented is likely more complex and is probably affected by multiple factors. Juvenile suckers that are entrained at the A Canal and Link River Dam could be dispersing, showing an avoidance response to poor habitat conditions, or exhibiting a combination of these and other factors. Gutermuth et al. (2000a, b) found that entrainment of suckers at the Link River was higher during poor water quality events; thus leaving the lake could be an avoidance response because fish tend to avoid unfavorable conditions, such as low DO or high water temperatures (Sullivan et al. 2003). As a natural part of sucker life history in UKL, young suckers likely dispersed downstream from UKL to rear in Lower Klamath Lake and then returned to UKL as adults. That cycle was likely broken when access to Lower Klamath Lake was blocked by the construction of the railroad embankment in the early 1900s (Weddell 2000, Foster 2002). Further disruption of the dispersal pattern from UKL to Lower Klamath Lake occurred with the construction of the

Link River Dam in the early 1920s. Now, most suckers that are entrained at the Link River Dam are considered lost to the breeding populations in UKL (USFWS 2007c, 2008), although small numbers of adults annually return to UKL via the new fish ladder on the Link River Dam (Kyger and Wilkens 2010).

Entrainment is more likely to occur now, compared to the pre-Project condition, because deep channels were cut through the reefs at the outlet of the lake when the Link River Dam was constructed (USBR 2001). The shallow depths over much of the reefs likely reduced downstream movement of juvenile and adult suckers from UKL, but may have had no effect on larvae, which are weaker swimmers and surface oriented.

Based on studies at the outlet of UKL, most age-0 juvenile sucker losses from the lake that result from emigration and entrainment at the UKL outlet occur in July through October, with a peak in August and September (Gutermuth et al. 2000a, b; Foster and Bennetts 2006; Tyler 2007; Korson et al. 2011; Korson and Kyger 2012).

Larval and juvenile survival in Keno Reservoir is likely low due to the poor water quality, degraded habitat, large numbers of non-native fishes, parasites, and loss of lake and wetland habitat due to agriculture conversion, railway construction, and near constant water level management (USFWS 2007c, 2008). Adult suckers in Keno Reservoir appear to avoid adverse water quality in the reservoir by moving into the Link River, which has higher concentrations of dissolved oxygen (Piaskowski 2003). Juvenile suckers are known to use marshes in Keno Reservoir; in 2010, Reclamation biologists captured 70 age-0 juvenile suckers in the largest remaining marsh in the Keno Reservoir, which is called "Tule Smoke" (Phillips et al. 2011). However, because DO levels reached potentially lethal concentrations of below 2 mg/L numerous times during the study, therefore current conditions likely do not provide habitat consistent enough for sucker survival.

Mortalities at Link River, Keno, J.C. Boyle, Copco, and Iron Gate Dams

Of the estimated 4.9 million sucker larvae, 33,000 juveniles, and 40 sub-adult/adults that are entrained at Link River Dam and the East Side and West Side facilities each year and move downstream through Project facilities, we estimate that approximately 813,000 total sucker eggs, larvae, juveniles, and adult LRS and SNS die as a result of injuries received from turbines, spillways, and flow lines (Table 4.2). The largest source of mortality is from turbines, which primarily affects larvae; adult sucker mortalities are believed to be few because entrainment rates of adults are low based on estimates obtained by Gutermuth et al. (2000a, b).

Based on our analysis of effects from accidental reductions in ramp rates that strand suckers and normal reservoir fluctuations that arise from daily operations at the six dams on the Link and Klamath Rivers, we estimate that annual mortality rates are approximately: 15,000 total sucker eggs, larvae, and juveniles; the number of adult suckers affected by ramp rate changes and reservoir fluctuations is believed to be close to zero (Table 4.2). Effects to suckers from ramp rates and reservoir fluctuations are believed to be greatest at J.C. Boyle Reservoir because it is the upstream-most hydropower reservoir and is nearest to the source populations of suckers in UKL; effects are least in Copco No. 2 and Iron Gate Reservoirs, which are downstream and farthest from the source populations in UKL.

Table 4.2. Estimated maximum annual sucker mortality under current operations at link river dam and the Klamath Hydroelectric Project facilities due to turbines, spillways, flow lines, reservoir fluctuations, and stranding.

Life Stage	Facility							
	Link River Dam ^A	East Side & West Side ^B	Keno Dam	J.C. Boyle Dam	Copco No. 1 Dam	Copco No. 2 Dam	Iron Gate Dam	Total
Estimated Annual Mortality^C Due to Turbine, Spillway, and Flow-line Operations								
Larvae	38,995	731,161	8,208	9,500	13,268	9,951	733	811,815
Juveniles	594	66	65	77	6	5	0	814
Adults	1	4	0	0	0	0	0	5
Total	39,590	731,231	8,273	9,577	13,274	9,956	733	812,634
Estimated Annual Mortality^C Due to Reservoir Fluctuations and Stranding Effects								
Eggs	0	0	0	10,000	0	0	0	10,000
Larvae	1,000	0	400	3,000	200	20	100	4,720
Juvenile	100	0	20	205	50	0	0	375
Adult	0	0	0	0	0	0	0	0
Total	1,100	0	420	13,205	250	20	100	15,095
Grand Total	40,690	731,231	8,693	22,782	13,524	9,976	833	827,729

A: Mortality estimates in this column are based on spill releases at Link River Dam, which are attributable to Reclamation's operations.

B. The estimate for mortality at the East Side and West Side facilities is based on passage or entrainment through the East Side and West Side turbines or flow lines. Under current operations, the East Side and West Side turbines are offline during the August – October peak entrainment period for juveniles and adults as explained in the text, but relatively small amounts of water pass (approximately 80 cfs total) through the flow lines.

C. Annual mortality is defined as the estimated maximum number of individuals killed from the encounters with the listed operational sources. Total mortality includes losses resulting from spill at Link River Dam. Spillway mortality associated with Link River Dam is attributable to Reclamation's operations.

The total annual mortality of all sucker life stages owing to current operations of all dams and associated facilities downstream of UKL equals approximately 828,000, with approximately 99 percent of this total being sucker eggs and larvae.

Effects of Migration Barriers

Historically, larval and juvenile suckers dispersing from UKL to the Klamath River above Keno Dam and Lower Klamath Lake probably reared in this shallow productive environment with extensive emergent wetlands and returned to UKL and its tributaries to spawn as adults (Gutermuth et al. 2000a, USFWS 2007a). Now, most suckers dispersing downstream of UKL

likely perish due to the lack of rearing habitat and poor water quality in Keno Reservoir or disperse downstream below Keno Dam (USFWS 2007a, 2008). Before the development of PacifiCorp's Klamath Hydroelectric Project, some suckers dispersing into the Klamath River below Keno Dam probably moved back upstream into lacustrine habitat. Suckers that did not return upstream over the reef at Keno Dam were likely lost downstream. Currently, because of the presence of lake habitats available in J.C. Boyle, Copco, and Iron Gate Reservoirs, refuge populations exist there, consisting mostly of adult SNS that probably dispersed from upstream habitats as larvae and juveniles (Desjardins and Markle 2000).

In 2005, Reclamation built a new fishway at the Link River Dam that meets recommended design criteria and guidelines for upstream fish passage of federally-listed suckers (USFWS 2005). In 2005, Reclamation installed a PIT tag detection system, and a fish trap at the top end of the fishway in 2007 to monitor fish passage at the facility. Monitoring results indicate both LRS and SNS are passing upstream through this fish ladder, but in low numbers. For example, in 2010, 26 PIT-tagged suckers were detected moving through the ladder (Kyger and Wilkens 2010). However, an underdetermined number of untagged suckers likely also used the ladder.

The Link River contains a series of cascading drops consisting of bedrock and boulders. The main cascade provides a drop of about 15 feet in elevation over a length of about 450 feet. Nearly 10 feet of the drop is concentrated in a single cascade that is about 100 feet long. The main cascade starts about 320 feet downstream of the dam, with the steepest section starting about 500 feet downstream of the dam. Adult sucker passage may be restricted at low flows during the springtime spawning migration, when the drop at the cascade is greatest (PacifiCorp 1997, Mefford and Higgs 2006).

To address fish passage conditions in the cascade reach of Link River, Reclamation conducted a hydraulic modeling study (Mefford and Higgs 2006). Based on hydraulic simulations at flows ranging from 1,000 to 4,000 cfs, conditions supporting fish passage through the cascade become progressively worse at higher flows (Mefford and Higgs 2006). Therefore, during wet years when releases are several thousand cubic feet per second, sucker migration past the cascade may be restricted due to high velocities. Current operation of East Side and West Side facilities at Link River Dam likely restricts adult sucker migration at flows less than about 300 cfs in the Link River because of the location of turbine outlets and at flows greater than 3,000 cfs because of the flow hydraulics in the cascade reach. If fewer adults are able to migrate to spawning habitat in the Sprague and Williamson Rivers, production and recruitment to the LRS and SNS populations will be negatively impacted.

Although Keno Dam has a fish ladder, it does not meet Service and ODFW criteria for sucker passage (USFWS 2007a). The fishway slope is too steep for suckers and automated weirs 25 through 28 lack adequate orifice passage so that fish using the ladder have to jump over the last four weirs to pass into the reservoir (USFWS 2007a). Suckers will pass through orifices but are not known to jump over weirs. Also, the Keno Dam fishway and auxiliary water supply system have identified attraction hydraulics and flow regulation problems (USFWS 2007a).

Based on previous fish population monitoring in J.C. Boyle Reservoir (USBR 1993; Desjardin and Markle 2000), the adult listed sucker populations are likely up to several hundred individuals. Some of these fish may migrate up to Keno Dam each year during the springtime spawning migration. Thus, the current operation of the existing upstream fishway at Keno Dam may restrict upstream migration of endangered suckers from J.C. Boyle Reservoir and those entrained from UKL and Keno Reservoir.

No endangered suckers were documented using the J.C. Boyle Dam ladder in 1988-1991 (PacifiCorp 1997). ODFW identified numerous problems with this ladder that restrict fish passage, including lack of attraction flow, steep slope, high turbulence, small pool volume, poor entrance location, and flow fluctuations. However, current operation of the J.C. Boyle fish ladder has no impact to adult LRS and SNS because none appear to be attempting to migrate upstream of the dam to spawn or return to upstream rearing areas.

There are no upstream fishways (fish ladders) at Copco No. 1, Copco No. 2, and Iron Gate Dams. However, since adult endangered suckers are rare or absent in Copco No. 2 Reservoir, uncommon in Iron Gate Reservoir, and absent in the Klamath River below Iron Gate Dam due to the lack of lake or reservoir habitat, there are unlikely to be any adverse effects on upstream sucker spawning migrations at these facilities.

Other Effects to LRS and SNS in the Action Area

As a result of a 1968 contract between PacifiCorp and Reclamation for the operation of Keno Reservoir, the reservoir must generally be maintained at a water level between elevations 4,085.0 and 4,086.5 feet (USBR datum), except for several days during the spring when the surface elevation is drawn down 2 feet (0.6 m) to facilitate maintenance of irrigation facilities. Maintenance of a stable water level in Keno Reservoir facilitates consistent water delivery to dependent water users. Stable surface elevations in the Keno Reservoir could inhibit development of additional wetland habitats and degrade the quality of existing wetlands (USFWS 2007a). Although current maximum water levels in Keno Reservoir are thought to be similar to those that occurred naturally because of a reef near Keno that controlled water levels (Weddell 2000), minimum elevations could have been lower historically due to lower flows from UKL in the summer and fall. The maintenance of stable water levels in Keno Reservoir is not anticipated to affect the availability of deeper habitats used by older juvenile and adult suckers.

Downstream of UKL on the Link and Klamath Rivers there are six dams: Link River, Keno, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate. The reservoirs behind the dams were described previously under Section 4.1 *Status of LRS and SNS Populations in the Action Area*.

We previously determined that LRS and SNS are adversely impacted by the operation of the six dams, primarily from injuries caused by passing through turbines or spillways, but also as a result of rapid changes in flow or fluctuation in reservoir levels that strand suckers (USFWS 2007a, 2008). In Appendix 1, we provide a quantitative analysis of the current effects of the Link and Klamath River dams and reservoirs on LRS and SNS, based on available data and making appropriate assumptions.

4.4 Conservation Needs of the LRS and SNS in the Action Area – Klamath River Management Unit

Keno Dam to Iron Gate Dam. The Klamath River from Keno Dam to Iron Gate Dam encompasses the Klamath River Management Unit of the UKL Recovery Unit (USFWS 2013a). The NRC (2004) concluded that sucker populations in Klamath River reservoirs do not have a high priority for recovery because they are not part of the original habitat complex of the suckers and the reservoirs probably are inherently unsuitable for completion of life cycles of suckers. Individuals within this management unit are not genetically distinct from other management units that are outside the action area (Dowling 2005). However, the Klamath River Management Unit possesses some conservation value because suckers in the reservoirs provide redundancy until the species can be recovered in other units and therefore, should be conserved if at all possible. In other words, individual fish in these reservoirs provide some insurance against loss of other populations (NRC 2004) and could serve as “backup” to facilitate replacement of fish lost in another population if a catastrophic event happened. However, this value is minimal because: (1) the listed fish in the reservoirs are not self-sustaining; (2) there are relatively low numbers of individuals; (3) we have limited ability to capture fish within the reservoirs; and (4) there is not adequate fish passage for listed suckers to return to UKL where suitable spawning habitat exists. Therefore, the area downstream of Keno Dam serves as a sink for these species, and the Klamath River Management Unit may not be needed for recovery of the species.

Even if the dams are removed, the gradient of the Klamath River in this unit is likely too great to provide suitable habitat for these species or passage back to UKL and thus suckers that historically moved into this section of the Klamath River were likely lost from the population. The average gradient of the Link River (35 feet per mile) is about one-half (70 feet per mile) of the 2 mile reach below the Keno Dam. Furthermore, the Klamath River drops over 250 feet between Keno and J.C. Boyle Dams, making it unlikely that suckers would have sufficient stamina to swim that distance. It should also be noted that in our December 7, 2011, Revised Critical Habitat Proposed Rule for Lost River and Shortnose Sucker, the UKL and Keno management units were proposed as critical habitat. However, the Klamath River Management Unit below Keno was not proposed as critical habitat because it did not include the physical and biological features necessary for the conservation of the species. The final rule designated critical habitat in the Keno Reservoir, but not downstream below the Keno Dam (USFWS 2012).

Iron Gate Dam to Klamath River Mouth. There is no documentation of listed suckers currently or historically occupying this reach of the river, and therefore this section of the Klamath River was not designated as a management unit in the USFWS’s revised recovery plan (USFWS 2013a). It is likely that some listed larvae and juvenile suckers are currently moving into this reach of the Klamath River via passive transport through Iron Gate Dam. However, there is no lake habitat below the dam for these fish to feed or rear and no opportunity for these suckers to return upstream to Iron Gate Reservoir; therefore, it is unlikely that listed suckers occur below Iron Gate Dam.

4.5 Habitat Conditions and Status of the LRS and SNS in the UKL Recovery Unit

The Upper Klamath Lake Recovery Unit encompasses most of the occupied range of the LRS and the SNS, including UKL and the Klamath River downstream to Iron Gate Dam. Listed suckers do not occur downstream from Iron Gate Dam (USFWS 2013a, b, c). The UKL Recovery Unit is subdivided into four management units: (1) UKL river-spawning individuals; (2) UKL spring-spawning individuals (LRS only); (3) the Keno Reservoir Unit, including the area from Link River Dam to Keno Dam; and (4) the reservoirs along the Klamath River downstream from Keno Dam, known as the Klamath River Management Unit.

UKL is critically important to these species because it supports a large population of the SNS and the largest population of the LRS, and is the primary rearing habitat for all life stages in the sub-basin (USFWS 2013a, b, c). Keno Reservoir and the Klamath River reservoirs lack suitable conditions for self-sustaining sucker populations and thus are viewed as sink populations; nonetheless they are important for recovery because they provide population redundancy and could be used to repopulate lost populations if they can be effectively caught. All populations of the LRS and the SNS below UKL are considered to be derived from dispersal/entrainment from UKL and thus are identified as a sink population (USFWS 2008, 2013a, b, c).

The major threats to the LRS and the SNS conservation in the UKL recovery unit are poor water quality (i.e., high pH and ammonia, low DO, and algal toxins), associated disease and parasites, inadequate water levels at key periods, and entrainment into agricultural diversions, especially at the Link River Dam and nearby A Canal (USFWS 2013a, b, c). These threats mostly affect resiliency of the LRS and the SNS populations by reducing their abundance and productivity; however, as sucker populations diminish in abundance, redundancy is threatened because smaller populations are at a higher risk of extirpation. The major threat to LRS and SNS in areas downstream from UKL is water quality, which is extremely poor in the summer (ODEQ 2010).

4.6 Climate Change

The Oregon Climate Division 5 (includes the high plateau area of the upper Klamath Basin) temperature dataset and the U.S. Historical Climatology Network temperature dataset for Crater Lake show warming trends in winter temperatures since the 1970s (Mayer 2008). Recent winter temperatures are as warm as or warmer than any time during the last 80 to 100 years (Mayer 2008). Air temperatures over the region have increased by about 1.8 to 3.6° F (1 to 2° C) over the past 50 years and water temperatures in the Klamath River and some tributaries have also been increasing (Bartholow 2005, Flint and Flint 2012). Reclamation (2011) reports that the mean annual temperature in Jackson and Klamath Counties, Oregon, and Siskiyou County, California, increased by slightly less than 1.8° F (1° C) between 1970 and 2010. During the same period, total precipitation for the same counties decreased by approximately 2 inches (5.08 cm) (USBR 2011).

In conjunction with rising temperatures, snow water equivalent has been declining. Regonda et al. (2005) analyzed western states data from 1950 through 1999, including data from the Cascade Mountains of southern Oregon. Their findings show a decline in snow-water equivalent of greater than 6 inches (15.24 cm), an approximate 20 percent reduction in snow water equivalent, during March, April, and May in the southern Oregon Cascades for the 50-year period evaluated.

Analysis of climatologic and hydrologic information for the upper Klamath Basin indicates UKL inflows, particularly base-flows, have declined over the last several decades (Mayer and Naman 2011). Recent analyses completed for this BiOp confirm the trend in declining inflow to UKL from 1981 through 2012, and also demonstrate declining flows in the Sprague and Williamson Rivers (major tributaries to UKL) during the period of record. However, trends change markedly depending on the selected period of record and trends for different time frames (e.g., 1991 through 2012 and 2001 through 2012) demonstrate increasing net inflow to UKL. Inflow to UKL and flow in the Sprague and Williamson Rivers are strongly dependent on climate, particularly precipitation, as demonstrated in Mayer and Naman (2011). Part of the decline in flow is explained by changing patterns in precipitation; however, other factors are very likely involved as well, including increasing temperature, decreasing snow-water equivalent, increasing evapotranspiration, and increasing surface water diversions or groundwater pumping upstream of UKL (Mayer and Naman 2011).

Projections of the effects of climate change in the Klamath Basin suggest temperature will increase in comparison to a 1961 through 2000 comparison period (Barr et al. 2010; USBR 2011). Projections are based on ensemble forecasts from several global climate models and carbon emissions scenarios. Although none of the projections include data for the specific period of the proposed action, anticipated temperature increases during the 2020s compared to the 1990s range from 0.9 to 1.4° F (0.5 to 0.8° C) (USBR 2011). During the 2035 and 2045 period, temperature increases are expected to range from 2.0 to 3.6° F (1.1 to 2.0° C), with greater increases in the summer months and lesser increases in winter (Barr et al. 2010).

Effects of climate change on precipitation are substantially more difficult to estimate, and models used for the Klamath Basin suggest decreases and increases. During the 2020s, Reclamation (2011) projects an annual increase in precipitation of approximately 3 percent compared to the 1990s. Reclamation (2011) also suggests that an increase in evapotranspiration will likely offset the increase in precipitation. In the 2035 and 2045 period, the change in annual precipitation compared to the 1961 through 1990 is expected to range from approximately -9 percent to +3 percent (Barr et al. 2010). Within the boundaries of the annual change in precipitation, December through February precipitation is expected to increase by up to 10 percent while June through August precipitation is expected to decrease between 15 and 23 percent (Barr et al. 2010).

Reclamation (2011) projects that snow-water equivalent during the 2020s will decrease throughout most of the Klamath Basin, often dramatically, from values in the 1990s. Projections suggest that snow-water equivalent will decrease 20 to 50 percent in the high plateau areas of the upper basin, including the Williamson River drainage. Snow-water equivalent is expected to decrease by 50 to 100 percent in the Sprague River basin and in the vicinity of Klamath Falls. In the lower Klamath Basin, Reclamation projects decreases in snow-water equivalent between 20 and 100 percent. The exception to the declines is the southern Oregon Cascade Mountains, where snow-water equivalent is projected to be stable or increase up to 10 percent (USBR 2011).

Reclamation also projects annual increases in runoff during the 2020s compared to the 1990s, based on the global climate models. The annual volume of flow in the Williamson River is expected to increase by approximately 8 percent, with increases of approximately 22 percent

during December through March and decreases of approximately 3 percent during April through July (USBR 2011). The Klamath River below Iron Gate Dam is expected to experience approximately a 5 percent increase in annual flow volume, with increases of approximately 30 percent during December through March and decreases of approximately 7 percent during April through July (USBR 2011).

The apparent contradiction between decreasing snow-water equivalent and increasing runoff is explained by projections suggesting a greater proportion of precipitation will fall as rain instead of snow, and the increase in overall precipitation will be greater in the winter than in the summer.

The USGS has modeled potential responses to climate change in the Sprague River Basin using several global climate models and carbon emissions scenarios (Markstrom et al. 2011, Risley et al. 2012). The models simulated the effects of climate change between 2000 and 2100 compared to a 12-year baseline period of water years 1988 through 1999. The results indicate steady increases in temperature and substantial variability with regard to future precipitation, streamflow, evapotranspiration, and groundwater flow. Projected results for the Sprague River basin for the decade between 2010 and 2020 under the most likely carbon emission scenarios have been estimated, based on the overall 2000 through 2100 simulations. These results for the 2010 to 2020 decade include:

- An increase in mean maximum temperature ranging from approximately 0.36 to 0.54 °F (0.20 to 0.35 °C).
- An increase in mean minimum temperature ranging from approximately 0.18 to 0.81 °F (0.10 to 0.45 °C).
- A change in mean precipitation ranging from near zero to an increase of approximately 1 in (2.54 cm) per year.
- A change in mean surface water runoff ranging from near zero to an increase of approximately 4 cfs (0.11 m³/sec).
- A change in mean streamflow ranging from near zero to an increase of approximately 60 cfs (1.7 m³/sec).
- A change in mean groundwater flow ranging from a decrease of approximately 4 cfs (0.1 m³/sec) to an increase of approximately 25 cfs (0.7 m³/sec).
- A change in mean evapotranspiration ranging from a decrease of approximately 0.15 in (.37 cm) per year to an increase of approximately 0.8 in (2.0 cm) per year.
- A shift in peak streamflow over the course of the 21st Century from mid–April to early– or mid–March.

In addition to having multiple hydrologic effects, climate change is likely to affect biological resources in the Klamath Basin. Climate change could exacerbate existing poor habitat conditions for fish by further degrading water quality. Higher water temperatures are of concern in UKL because the weather conditions documented during the last three fish die-offs in the lake were characterized by higher than average temperatures (USFWS 2012), suggesting that temperature plays a key role in the events. Because UKL is shallow, water temperatures tend to closely follow air temperatures; even a week of high air temperatures will increase water temperatures in the lake (Wood et al. 2006).

Higher water temperatures could have multiple adverse effects on suckers, including: (1) extending the growing season for AFA, perhaps leading to higher AFA biomass; (2) stressing AFA earlier or later in the season, causing more frequent bloom collapses that could affect water quality later in the season; (3) increasing respiration rates of microorganisms, thus elevating DO consumption in the water column and in sediments; (4) raising respiration rates for suckers and other fish, making it more difficult for them to obtain sufficient DO; and (5) reducing the DO holding capacity of water, which is highest in cold water. Other factors, such as predation and parasitism rates and incidences of disease might also increase as a result of higher water temperatures. Nonnative fishes that could prey on or compete with suckers could also increase in numbers and diversity as a result of higher temperatures. The productivity of UKL and sucker growth rates might increase as a result of higher temperatures, but if higher temperatures lead to reduced water quality, the benefits could be negated. Because of the complex nature of the lake ecosystem and the lack of knowledge regarding impacts of climate change on aquatic systems, it is difficult to predict what ecological changes are likely to occur as climate warms. However, most of the effects seem likely to be negative, and therefore will likely exacerbate the current seasonally poor habitat conditions. Although the greatest effects of climate change on LRS and SNS habitat conditions are likely to be decades away, some adverse effects are likely to occur during the term of this consultation.

4.7 Conclusions Regarding the Ability of the Action Area to Support LRS and SNS Conservation

The revised recovery plan for the LRS and the SNS establishes a strategy that is intended to produce healthy, self-sustaining populations of the LRS and the SNS within the action area by reducing sucker mortality; restoring habitat, including sucker spawning, larval, and juvenile habitats; and increasing connectivity between sucker spawning and rearing habitats (USFWS 2013a). Recovery also involves ameliorating the adverse effects of degraded water quality, disease, and nonnative fish on LRS and SNS populations. The recovery goal is to produce naturally self-sustaining populations that possess healthy long-term demographic traits and trends (USFWS 2013a).

Keno Reservoir and the downstream hydroelectric reservoirs are highly altered systems that currently support small sucker populations, mostly comprised of SNS. All of these areas provide recovery benefits by adding redundancy, but currently they do not support self-sustaining populations because of habitat limitations. Because Keno Reservoir is downstream of UKL, and large numbers of suckers disperse there from upstream, it has the potential to provide rearing habitat for suckers that ultimately could migrate back to UKL. Nevertheless, habitat and water quality conditions in the Keno Reservoir are seasonally adverse and are unlikely to change substantially over the next decade because they are driven by conditions in UKL that are not easily ameliorated (NRC 2004).

Based on the best available information on the range-wide status of the LRS and the SNS and the factors influencing that status, the USFWS concludes that the LRS and the SNS are critically endangered due to the lack of population resiliency and redundancy. Further, these species are at a high risk of extinction unless and until sufficient amounts of recruitment occur into the adult breeding populations of both species to more normalize population age structure, demographic

patterns, and relative distribution within the Klamath River Basin. Although considerable efforts have been made to reduce the threats to the LRS and the SNS, all of the threats discussed above are extremely difficult to address in the short-term, or, like climate change, cannot be reduced and consequently are unlikely to be substantially ameliorated in the near future.

5.0 EFFECTS OF THE PROPOSED ACTION

This section presents an analysis of the beneficial and adverse, and 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 following definitions of terms from the statement above are from 50 CFR §402.02. Indirect effects are caused by or result from the proposed action and are later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on that larger action for their justification. Interdependent actions have no independent utility apart from the proposed action.

In Section 4 above, we described the factors affecting the species environment in the action area, including effects of the hydroelectric Project. Those effects included: spillway and turbine mortality, stranding and ramp rate effects, effects from reservoir fluctuations, effects of migration barriers and false attractions, and water quality effects (USFWS 2007a). In Tables 5.1 and 5.2 below, we present summaries of the maximum level of harassment and lethal take of LRS and SNS that is anticipated to occur as a result of the operation of the hydroelectric Project under the HCP. With implementation of the conservation measures proposed by the Applicant, sucker mortality attributable to PacifiCorp's operations of the East Side and West Side will be greatly reduced because the turbines will not operate, except for brief (<1 day) testing or other non-generation purposes, during times when suckers are unlikely present, until the facilities are decommissioned; however, there will be an 80 cfs flow through the East Side flow line that will likely result in some mortality (assumed to be 2 percent of suckers passing through the flow line).

In developing the larval entrainment estimates we used data obtained in 2012 at the Link River by Simon et al. (2013). For juvenile and adult suckers, we used entrainment estimates obtained by Gutermuth et al. (2000a, b), which were revised based on estimated declines in LRS and SNS population sizes in UKL that have occurred since the late 1990s (NMFS and USFWS 2013). Because the total number of adult LRS and SNS in UKL has likely declined about 80 percent since 1998, we assume numbers of larvae and juveniles present in the lake and entrained in water diversions (i.e., A Canal, Link River Dam, and East Side and West Side facilities) at the outlet of the lake has also decreased because fewer adult females are now present, resulting in reduced total production of eggs (NMFS and USFWS 2013). Therefore, we assume entrainment of juveniles and adult suckers at water diversions from the Link River is now 20 percent of what it was in 1998 (NMFS and USFWS 2013).

Table 5.1. Estimates of LRS and SNS mortality from operations at PacifiCorp’s seven Project facilities under current conditions (with East Side and West Side facilities operational), and with the implementation of the proposed conservation measures in the HCP (i.e., without operating turbines at the East Side and West Side facilities, but maintaining 80 cfs flow through the East Side flow line).

Sucker Life Stage and Facility	Estimated Mortality without HCP			Estimated Mortality with HCP		
	Turbine	Spillway and Flow line	Reservoir Fluctuations & Stranding	Turbine	Spillway and Flow line	Reservoir Fluctuations & Stranding
Eggs						
J.C. Boyle Dam	0	0	10,000	0	0	10,000
Larvae						
East Side/West Side	731,161	Included in turbine mortality	0	0	16,573	0
Keno Dam	0	8,208	400	0	9,554	456
J.C. Boyle Dam	9,452	48	3,000	11,001	56	3,492
Copco No. 1 Dam	13,268	0	200	13,394	0	233
Copco No. 2 Dam	9,951	0	20	10,045	0	20
Iron Gate Dam	731	1	100	738	1	101
<i>Total</i>	<i>764,563</i>	<i>8,257</i>	<i>3,720</i>	<i>35,178</i>	<i>26,184</i>	<i>4,302</i>
Juveniles						
East Side/West Side	0	66	0	0	66	0
Keno Dam	0	65	20	0	65	20
J.C. Boyle Dam	77	0	205	77	0	205
Copco No. 1 Dam	6	0	50	6	0	50
Copco No. 2 Dam	5	0	0	5	0	0
Iron Gate Dam	1	0	0	1	0	0
<i>Total</i>	<i>89</i>	<i>131</i>	<i>275</i>	<i>89</i>	<i>131</i>	<i>275</i>
Adults						
East Side/West Side	4	0	0	0	0	0
Keno Dam and downstream	0	0	0	0	0	0
<i>Total</i>	<i>4</i>	<i>1</i>	<i>0</i>	<i>0</i>	<i>1</i>	<i>0</i>
<i>Grand Total</i>	<i>764,656</i>	<i>8,388</i>	<i>13,995</i>	<i>35,267</i>	<i>26,315</i>	<i>14,577</i>

As a result of taking East Side and West Side turbines offline, except for brief testing, annual mortality of suckers by the Project is likely to be reduced by 90 percent or approximately 710,000 suckers, based on the estimates shown in Table 5.1. Most of this decrease is due to fewer larvae being taken. Mortality of juveniles, and especially adults, under either scenario is small. Once East Side and West Side turbines are taken offline, there will be a small increase in the amount of take attributable to PacifiCorp's operations between Keno and Iron Gate Dams due to increased numbers of larval suckers surviving and moving downstream.

In Table 5.2 below, we summarize the amount of take of LRS and SNS that is anticipated to occur once the HCP is implemented. To estimate harassment take, we assumed that all suckers that are alive after moving through each of the seven Project facilities will be harassed. We assumed some suckers could be harassed multiple times by passing through more than one facility. As a result, we estimate that up to approximately 76,000 total LRS and SNS are likely to be lethally taken each year and up to 1.4 million harassed for a total annual take of up to approximately 1.5 million for both species combined (Table 5.2). Most (99 percent) of the take is of larvae and eggs. The numbers of adults that are likely to be taken is shown in Table 5.2 as being no more than 30. Note that in developing this number, we assumed a small number (up to five adults) are likely to be killed by a variety of causes not shown in Table 5.1. Most of these suckers are likely to be SNS based on identifications of suckers present in the reservoirs.

Table 5.2. Estimated total maximum annual harassment and lethal take of LRS and SNS by PacifiCorp's Klamath Hydroelectric Project under the HCP.

Life Stage	Harassment Take	Lethal Take	Total
Eggs	0	10,000	10,000
Larvae	1,388,562	65,664	1,454,226
Juveniles	6,676	495	7,170
Adults	25	5 ¹	30
Total	1,395,263	76,164	1,471,427

1. We assumed a small number (up to five adults) are likely to be killed by a variety of causes not specifically shown in Table 5.1.

6.0 CUMULATIVE EFFECTS

Cumulative effects are those impacts of future State, Tribal, and private actions that are reasonably certain to occur within the area of the action, and are subject to consultation. There are no Tribal lands within the action area. Future Federal actions will be subject to the consultation requirements established in Section 7 of the Act, and therefore are not considered cumulative to the proposed action.

The following non-Federal activities are proposed in the action area:

- 1) The State of Oregon is enlarging its fish screening program in the Klamath Basin. Following completion of adjudication, diversions will require water measurement devices and fish screens. Although the screen mesh openings are large enough to allow larval suckers to pass, the screen design prevents entrainment of juvenile and adult suckers greater than 1.2 inches (30 mm) total length. This will result in a significant reduction in

entrainment; however, we have no information at this time to identify how many screens and the location of screens over the next 10 years to quantify this benefit.

- 2) The Upper Klamath Conservation Action Network (UKCAN) works collaboratively to restore watershed processes through adaptive management. UKCAN takes an ecosystem approach, and the group focuses on conservation priorities that will benefit suckers, including restoration activities to improve both water quality and physical processes. As of 2013, funding comes through the National Fish and Wildlife Foundation's Upper Klamath Basin Keystone Initiative and the Oregon Watershed Enhancement Board's Klamath Special Investment Partnership. UKCAN partners include the Klamath Basin Rangeland Trust, Klamath Watershed Partnership, The Klamath Tribes, The Nature Conservancy, Sustainable Northwest, Klamath Soil and Water Conservation District, Upper Klamath Water Users Association, and USFWS. UKCAN work focuses geographically on the UKL watershed, which includes the UKL, Williamson, Sprague, and Wood River sub-watersheds, as well as the Spencer Creek watershed. UKCAN has developed restoration priority actions at finer geographic scales and refines those priorities as new information is made available. Due to the funding processes, UKCAN is uncertain about the amount of restoration work that will occur in the future. However, given the amount of focused effort and the involvement of several key organizations in the upper Klamath Basin, progress is expected toward the group's priorities over the next 10 years that will be measureable at some scales.
- 3) The Lost River and Klamath River TMDL in California and Oregon is completed (ODEQ 2010). Once the TMDL is approved, governmental and private entities contributing to the degradation of water quality in those rivers will be required to develop and implement water quality management plans that reduce nutrient loading and aid in the improvement of water quality in the Klamath River, which should benefit suckers.

Most of the non-Federal actions listed above will improve water quantity, water quality, and habitat in areas that support listed suckers, including UKL, its tributaries and the Keno Reservoir. Screening will reduce entrainment of suckers and improve overall survival. Habitat restoration will increase the amount and quality of areas important to complete sucker life cycles. Water quality improvement projects will work towards addressing a major factor limiting listed sucker recovery in the upper Klamath Basin. If water quality is improved in Keno Reservoir, this area would likely support a substantial population of adult suckers and/or provide habitat to support larval and juvenile suckers that perhaps could eventually return to UKL as adults. Therefore, the effects of the proposed action, combined with future State, Tribal, and private actions, will only result in beneficial cumulative effects to listed suckers over the next 10 years; however, none of the benefits can be quantified at this time because specific project details are not available.

7.0 CRITICAL HABITAT

7.1 Status and Environmental Baseline of LRS and SNS Critical Habitat

On December 11, 2012, the USFWS published a final rule designating critical habitat for the LRS and the SNS (77 FR 73740). The designation included two critical habitat units (CHUs) for

each species and the units include a mix of Federal, State and private lands. The Upper Klamath Lake Critical Habitat Unit 1, situated in Klamath County, Oregon, includes UKL and Agency Lake, the Link River and upper Klamath River downstream to Keno Dam, as well as portions of the Williamson and Sprague Rivers, for a total of approximately 90,000 acres (36,422 ha) and 120 river miles. The Lost River Basin Critical Habitat Unit 2 is situated in Klamath and Lake Counties, Oregon, and Modoc County, California. It includes Clear Lake and its main tributary, Willow Creek, for both the LRS and the SNS, and Gerber Reservoir and its main tributaries for the SNS only, for a total of approximately 33,000 acres (13,355 ha) and 88 river miles.

Designated critical habitat for the LRS and SNS in the Project area is only within Unit 1 (Figure 7.1), and that portion of Unit 1 that is within critical habitat is confined to the Keno Reservoir, which includes Lake Ewauna. No critical habitat was designated for any of the reaches of the Klamath River below Keno Dam, so most of the Project (i.e., J.C. Boyle, Copco No.1 and 2, and Iron Gate Reservoirs) is outside of designated critical habitat.

In accordance with Sections 3(5)(A)(i) and 4(b)(1)(A) of the ESA and regulations at 50 CFR 424.12, in determining which areas within the geographical area occupied by the species at the time of listing to designate as critical habitat, we considered the physical and biological features essential to the conservation of the species which may require special management considerations or protection.

The following physical and biological features were considered essential to the conservation of each sucker species and may require special management considerations or protection:

- (1) Space for individual and population growth, and for normal behavior;
- (2) Food, water, air, light, minerals, or other nutritional or physiological requirements;
- (3) Cover or shelter;
- (4) Sites for breeding, reproduction, or rearing (or development) of offspring; and
- (5) Habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species.

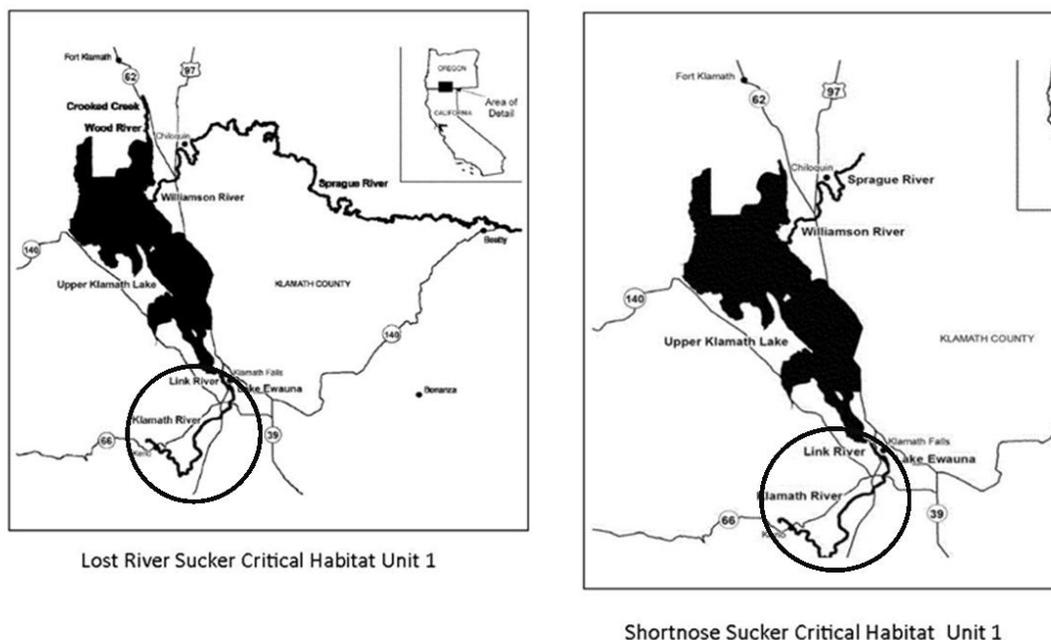


Figure 7.1. Maps showing designated critical habitat Unit 1 for the LRS and the SNS. The area within the circles is that part of Unit 1 that is within the action area.

The primary constituent elements (PCEs) of critical habitat are the specific elements of physical and biological features essential to the conservation of the species. Based on our current knowledge of the habitat characteristics required to sustain the species' life-history processes, the PCEs specific to self-sustaining LRS and SNS populations are:

- PCE 1—*Water*. Areas with sufficient water quantity and depth within lakes, reservoirs, streams, marshes, springs, groundwater sources, and refuge habitats with minimal physical, biological, or chemical impediments to connectivity. Water must have varied depths to accommodate each life stage: Shallow water (up to 3.28 feet [1.0 m]) for larval life stage and deeper water (up to 14.8 feet [4.5 m]) for older life stages. The water quality characteristics should include water temperatures of less than 28.0 °C (82.4 °F); pH less than 9.75; dissolved oxygen levels greater than 4.0 mg per L; low levels of microcystin; and un-ionized ammonia (less than 0.5 mg per L). Elements also include natural flow regimes that provide flows during the appropriate time of year or, if flows are controlled, minimal flow departure from a natural hydrograph.
- PCE 2—*Spawning and Rearing Habitat*. Streams and shoreline springs with gravel and cobble substrate at depths typically less than 4.3 feet (1.3 m) with adequate stream velocity to allow spawning to occur. Areas containing emergent vegetation adjacent to open water, provides habitat for rearing and facilitates growth and survival of suckers, as well as protection from predation and protection from currents and turbulence.

- PCE 3—*Food*. Areas that contain abundant forage base, including a broad array of aquatic macroinvertebrates.

The need for special management considerations also includes the following:

- Protect and improve water quality by reducing sediment and nutrient loading
- Manage water bodies so that there is minimal departure from a natural hydrograph
- Maintain, improve, or reestablish instream flows to improve the quantity of water available
- Manage groundwater use to ensure it does not affect surface waters
- Address water level fluctuations in reservoirs
- Maintain appropriate depths in water quality refuge areas for access and maintain buffers around refuge areas
- Maintain habitat in reservoirs, the timing and volume of water diverted needs to be addressed
- Improve access to spawning and rearing habitats
- Manage exotic fishes by restoring habitats for native fishes.

These are discussed in greater detail in the final critical habitat rule (77 FR 73740).

7.2 Analytical Approach and Role of Critical Habitat in LRS and SNS Recovery

This BO does not rely on the regulatory definition of “destruction or adverse modification” of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this BO relies on four components: (1) the status of critical habitat, which evaluates the range-wide condition of designated critical habitat for the LRS and the SNS in terms of primary constituent elements (PCEs), factors responsible for that condition, and the intended recovery function of the critical habitat overall, as well as the intended recovery function in general of critical habitat units; (2) the environmental baseline, which evaluates the condition of the critical habitat in the action area, factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the effects of the action, which determines direct and indirect impacts of the proposed Federal action and effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units; and (4) cumulative effects, which evaluates the effects of future non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal action on LRS and SNS critical habitat are evaluated in the context of the range-wide condition of the critical habitat, taking into account cumulative effects to determine if the critical habitat range-wide would remain functional (or would retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for these two species.

The analysis in this BO places an emphasis on using the intended range-wide recovery function of LRS and SNS critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the destruction or adverse modification determination.

An adverse modification analysis determines if the physical or biological features of critical habitat would remain functional to serve the intended recovery role for the species as a result of implementation of a proposed Federal action (77 FR 73740). The key factor related to the adverse modification determination is whether, with implementation of the proposed Federal action, the affected critical habitat would continue to serve its intended conservation role for the species. Activities that may destroy or adversely modify critical habitat are those that alter the physical or biological features to an extent that appreciably reduces the conservation value of critical habitat for the LRS and the SNS (77 FR 73740). The role of critical habitat is to support the life-history needs of the species and provide for the conservation of the species.

7.3 Effects of the Proposed HCP to LRS and SNS Critical Habitat

The portion of the critical habitat for the LRS and SNS that is within the Project area only includes the 20 mile and 2,500 acre reach of the upper Klamath River known as the Keno Reservoir, which is part of the much larger 120 mile-long and 90,000-acre Unit 1 described above (Figure 7.1). We anticipate that all three PCEs (i.e., water, spawning and rearing habitat, and food) will be affected to varying degrees as a result of operating the Project under the HCP. However, because there is no spawning habitat in the Keno Reservoir, that will not be affected.

The primary effect that PacifiCorp's operations have on critical habitat in Keno Reservoir is the result of maintenance of stable water levels. Water levels in the reservoir are managed by PacifiCorp by regulating flows at Link River Dam and at Keno Dam. A requirement for maintenance of stable water levels in the reservoir is contained within the 1968 contract between Reclamation and PacifiCorp that requires water levels to be maintained between an elevation of 4,085.0 and 4,085.5 feet. The main purpose of providing stable water levels in the reservoir is to ensure that Reclamation can deliver irrigation water to farmlands and Lower Klamath National Wildlife Refuge, which are serviced by the Lost River Diversion Channel, North and Ady Canals, and other smaller canals that originate in the Keno Reservoir. Those effects to sucker and their critical habitat were analyzed in the 2013 Klamath Project BiOp (NMFS and USFWS 2013). Because PacifiCorp has some discretion to manage water levels in the reservoir within the 0.5 foot range of elevations, adverse effects to critical habitat in Keno Reservoir could result, as described below.

Effects to PCE 1—Water

Stable water levels in the Keno Reservoir likely increase the hydraulic residence time, which increases the opportunity of the water to be affected by processes occurring in the reservoir that degrade water quality, such as biological and chemical oxygen demand. The residence time is also dependent on flows entering the reservoir (Table 2.1).

Quality of water entering, within, and leaving the Keno Reservoir is largely due to the quality of the water entering from UKL, which in summer contains large amounts of organic matter with an

associated high oxygen demand (Deas and Vaughn 2006, ODEQ 2010) and results in a 5 mg/L DO deficit. The increase in the hydraulic residence time in Keno Reservoir degrades water quality by increasing the DO deficit by an estimated 0.24 mg/L (ODEQ 2010). Additionally, wastewater, storm-water, agriculture, and refuge discharges enter the reservoir (ODEQ 2010).

Although, the Keno Dam is contributing to adverse water quality in the Keno Reservoir, its contribution is difficult to separate from other sources, and because the dam regulates water levels in the reservoir for agriculture, responsibility should be shared with Reclamation. Furthermore, because the residence time is affected by Link River flows, which are largely determined by Reclamation, it is difficult to sort out exactly what PacifiCorp's discretionary contribution is to adverse water quality in the reservoir. Over short time periods (probably hours), PacifiCorp can control flows in the summer when water quality is poor, but it must meet downstream flows at Iron Gate Dam, so its ability to control flow through the Keno Reservoir is limited. However to the degree that discretionary operation of the Keno Dam contributes to adverse water quality, those effects are limiting the ability of critical habitat in Keno Reservoir to provide sucker rearing and foraging habitats that are essential to the recovery of these species. Thus, operation of the Keno Dam is likely to have some unquantifiable negative effects to the recovery-support function of critical habitat for the LRS and the SNS in Keno Reservoir.

Effects to PCE 2—Spawning and Rearing Habitat

The ongoing management to operate for stable surface elevations in the Keno Reservoir is likely to retard development of additional wetland habitats and could degrade the quality of existing wetlands through controlled water depth; this is likely to adversely impact young suckers that use this habitat (USFWS 2007a). However, stable surface elevations do provide sucker access to the established wetland habitats for rearing during sucker early life history stages. To the degree that the Project is contributing to habitat degradation in Keno Reservoir, those effects are limiting the ability of critical habitat to provide sucker rearing and foraging habitats that are essential to the recovery of these species. Thus, the proposed action is likely to have some negative effects to the recovery-support function of critical habitat for the LRS and the SNS in the Keno Reservoir.

Effects to PCE 3—Food

Although we are not aware of any studies on invertebrates in the Keno Reservoir, we assume that invertebrate diversity and abundance at Keno Reservoir are high and are similar to those in UKL. Additionally, flows from UKL likely bring prey species such as amphipods, cladocerans, copepods, and midges into the reservoir, and the large amounts of organics that enter the reservoir from UKL could provide a substantial food base for invertebrates. For those reasons, the proposed action is not likely to reduce the recovery-support function of critical habitat to provide food for the LRS and the SNS in the Keno Reservoir.

7.4 Summary of Effects to LRS and SNS Critical Habitat Unit 1

Under the HCP, water quality in the Keno Reservoir would continue to be adversely affected by a variety of factors, primarily the input of organics from Upper Klamath Lake, but including operations at Keno Dam. However, the reservoir would continue to provide the recovery-support functions that are currently present because no changes in operations are anticipated. Although PacifiCorp's operations at the Keno Dam contribute to the poor water quality conditions in this reach, the contribution attributable to the Keno Dam is likely small and

difficult to assess because of multiple factors are affecting water-quality degradation and the responsibility is shared with Reclamation. The net effect of dam operations to critical habitat is small (1 percent of area affected) relative to the total area of designated critical habitat and is likely partially mitigated through restoration funded by the Sucker Conservation Strategy. Consequently, we anticipate that the proposed action will have a small adverse impact to critical habitat but is not likely to adversely modify or destroy critical habitat for the LRS and SNS.

7.5 Cumulative Effects to LRS and SNS Critical Habitat

Cumulative effects are those impacts of future State and private actions that are reasonably certain to occur within the area of the action subject to consultation. Future Federal actions will be subject to the consultation requirements established in Section 7 of the Act and therefore, are not considered cumulative to the proposed action. Most of the non-Federal actions listed in Section 6 will improve water quantity, water quality, and habitat in areas that support listed suckers, including UKL, its tributaries, and the Keno Reservoir. Screening will reduce entrainment of suckers and improve overall survival. Habitat restoration will increase the amount and quality of areas important to complete sucker life cycles. Water quality improvement projects will work towards addressing a major factor limiting listed sucker recovery in the upper Klamath Basin. If water quality (PCE1) is improved in Keno Reservoir, this area would likely support a substantial population of adult suckers and/or provide habitat to support larval and juvenile suckers (PCE2) that perhaps could eventually return to UKL as adults. These actions may provide indirect beneficial effects to food for listed suckers (PCE3). Therefore, the effects of the proposed action, combined with future State, Tribal, and private actions, will only result in beneficial cumulative effects to critical habitat for LRS and SNS over the next 10 years; however, none of the benefits can be quantified at this time because specific project details are not available.

8.0 CONCLUSION

After reviewing the current status of the LRS and SNS, 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 the proposed action is not likely to jeopardize the continued existence of the LRS or SNS, and is not likely to destroy or adversely modify proposed critical habitat for these species. The Service reached these conclusions based on the following synthesis of findings presented in previous sections of this BO.

8.1 Basis for the No-Jeopardy Determination

The Service finds that authorization of take under the HCP will not jeopardize the continued existence of the LRS and SNS because: (1) the amount of authorized take under the proposed HCP is reduced substantially (90 percent) from historic levels; (2) most of the authorized take is of sucker eggs and larvae that are produced in large numbers annually; (3) sucker populations in the hydropower reservoirs are not self-supporting and are likely dependent on upstream source populations to maintain themselves; (4) were it not for the reservoirs that are part of the Project, habitat for the LRS and SNS would likely not exist below Keno Dam; (5) LRS and SNS occurring in the reservoirs below Keno Dam do not have adequate upstream access, and

therefore these fish do not contribute to reproducing populations upstream that are essential for recovery; and (6) adverse effects to designated critical habitat by the Project are confined to Keno Reservoir, which represents a small fraction (~1%) of the total amount of designated critical habitat for the two species.

8.2 Basis for the Conclusion Regarding Destruction or Adverse Modification of Critical Habitat

The recovery-support function of critical habitat for LRS and SNS in the Keno Reservoir is adversely affected to some degree by the operations of Keno Dam; however, the reservoir is anticipated to provide the recovery-support conditions that are currently present because no changes in operations are anticipated. The area affected is small (approximately 1 percent) relative to the total area of designated critical habitat. Furthermore, those adverse effects to water quality that are attributable to PacifiCorp's discretionary actions are likely small compared to input of organics from UKL. Based on the information provided in this analysis, designated critical habitat is expected to provide the necessary recovery-support function for LRS and SNS. We believe that the proposed action will not alter the essential physical or biological features to an extent that it appreciably reduces the conservation value of critical habitat range-wide for LRS and SNS. Therefore, we do not anticipate that effects of the proposed action, taking into account cumulative effects, will result in the destruction or adverse modification of LRS and SNS critical habitat.

9.0 INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. 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 proposed action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The proposed PacifiCorp HCP and its associated documents clearly identify anticipated impacts to affected species likely to result from the proposed taking and the measures that are necessary and appropriate to minimize those impacts. All conservation measures described in the proposed HCP, together with the terms and conditions described in any associated Implementing Agreement and any section 10(a)(1)(B) permit or permits issued with respect to the proposed HCP, are hereby incorporated by reference as reasonable and prudent measures and terms and conditions within this Incidental Take Statement pursuant to 50 CFR 402.14(I). Such terms and conditions are non-discretionary and must be undertaken for the exemptions under section

10(a)(1)(B) and section 7(o)(2) of the Act to apply. If the permittee fails to adhere to these terms and conditions, the protective coverage of the section 10(a)(1)(B) permit and section 7(o)(2) may lapse. The amount or extent of incidental take anticipated under the proposed PacifiCorp HCP, associated reporting requirements, and provisions for disposition of dead or injured animals are as described in the HCP and its accompanying section 10(a)(1)(B) permit[s].

9.1 Amount or Extent of Anticipated Take

The Service proposes to issue an ITP to the Applicant under the authority of section 10(a)(1)(B) of the Act for a period of 10 years. The permit would authorize the incidental take of Lost River and shortnose suckers within the hydroelectric Project area extending from outlet of Upper Klamath Lake (RM 255) to Iron Gate Dam (RM 189). The Applicant has developed the Klamath Hydroelectric Project Interim Operations Habitat Conservation Plan for Lost River and Shortnose Suckers to avoid, minimize, and mitigate the effects of the taking that is authorized by the ITP. Total combined annual estimates of lethal take of LRS and SNS that will likely occur as a result of authorization of the ITP are approximately: 10,000 sucker eggs, 66,000 larvae, 500 juveniles, and up to five adults, and an annual harassment take of approximately 1,400,000 larvae, 6,700 juveniles, and 25 adults (Table 5.2). Note that take is combined for both sucker species because accurate identification of sucker eggs is not possible, and identification of larvae and juveniles can only be accurately determined to species in the laboratory using microscopic examination and X-rays, thus making identification impracticable for estimating take on an annual basis.

The Service expects that incidental take of the suckers will be difficult to detect or quantify because most of the take is of sucker eggs and larvae that are small, fragile, and not readily captured and identified. Consequently, we believe it is reasonable to use a surrogate that will enable the Applicant and the Service to know when the authorized level of take has been exceeded. We believe flow measurements (or the determination of the proportion of total flow) through the hydroelectric facilities is a useful surrogate to determine when take is exceeded because flow has been shown to be proportional to entrainment rates of sucker (Gutermuth (2000a, b), and flow can be accurately measured using data that the Applicant is already collecting.

Using the flow surrogate, authorized incidental take will be exceeded if the ratio of flow passing through the turbines relative to spillways is higher than is reasonably certain to occur over the permit term based on historic conditions. In our analysis, we assumed 94 percent of the annual flow passed through turbines at J.C. Boyle dam, 98 percent through turbines at Iron Gate dam, and 100 percent through turbines at Copco #1 and 2 dams. Because PacifiCorp's Project facilities make use of the available water in the river for generation purposes after minimum instream flow requirements have been met, the proportion of flow diverted to Project turbines on an annual basis varies depending on the water year type, with higher proportions of the overall flow being diverted into Project turbines during dry years and lower proportions diverted during wet years. It is not possible to forecast what water year types will be experienced during the permit term. However, the permit term will be long enough that a dry water year type is likely to occur. The flow proportions as above for the J.C. Boyle, Copco No. 1, Copco No. 2 and Iron

Gate facilities are based on flows routed through the turbines at Project facilities during recent operations in dry years (over the period 1994 to 2011). Thus, these flow proportions are reasonably foreseeable to occur during the permit term. If a greater proportion of the flow passes through the turbines relative to spillways, that will result in increased take above what we analyzed.

9.2 Effect of the Take

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the Lost River and shortnose suckers, or adverse modification of designated critical habitat for the two sucker species.

9.3 Reasonable and Prudent Measures with Terms and Conditions

The proposed Klamath Hydroelectric Project Interim Operations Habitat Conservation Plan for Lost River and Shortnose Suckers, Implementing Agreement, and the special Terms and Conditions of this section 10(a)(1)(B) permit issued with respect to the proposed HCP identify specific conservation measures necessary and appropriate to avoid, minimize, and mitigate the adverse effects of the Applicant's Covered Activities. All of the conservation measures described in the HCP, the implementing agreement, any associated documents, and the special Terms and Conditions of the permit are hereby incorporated by reference as reasonable and prudent measures, and Terms and Conditions for this Incidental Take Statement pursuant to 50 CFR 402.14(i). Such Terms and Conditions are non-discretionary and must be undertaken by the Permittee for the exemptions under section 10(a)(1)(B) and section 7(o)(2) of the Act to apply. If the Permittee fails to adhere to these Terms and Conditions, the protective coverage of the Permits and section 7(o)(2) may lapse.

Furthermore, the following Terms and Conditions apply to the Service after issuance of the Permit:

1. The Service shall provide technical assistance to the Permittee throughout the term of the Permit.
2. The Service shall ensure that all funded activities are consistent with the conservation goals of the HCP and the revised sucker recovery plan.

9.4 Reporting Requirements

In accordance with 50 CFR 402.14(I093), the Klamath Hydroelectric Project Interim Operations Habitat Conservation Plan for Lost River and Shortnose Suckers and associated documents specify provisions for monitoring and reporting the effects and effectiveness of the minimization and mitigation on the covered species and their habitats. The Permittee shall ensure that the reporting requirements proposed in the HCP are implemented. In addition, the following procedures shall be taken in the event that dead or injured covered species are located:

1. Upon finding a dead or injured covered species, the Permittee must notify the Service's Klamath Falls Fish and Wildlife Office in Klamath Falls at (541) 885-8481.

2. The Permittee must provide an explanation of the causes of the taking and review with the Service the need for possible modification of the protective measures.
3. The annual report, as described in the HCP, shall include, at a minimum, a discussion of whether authorized take has been exceeded based on monitoring of flow through turbines and spillways at the four hydroelectric dams.

10.0 REINITIATION NOTICE

This concludes formal consultation pursuant to the regulations implementing the Act, 50 C.F.R. §402.16. Reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (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 BO; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this BO; or (4) a new species is listed or critical habitat designated that 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.

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APPENDIX 1.

Analysis of Effects of Link River and Klamath River Dams on Lost River and Shortnose Suckers

Here we describe the effects that turbines, spillways, fluctuating reservoir water levels, varying ramp rates, and other actions have had on Lost River suckers (LRS) and shortnose suckers (SNS), as a result of operations of the Link River and Klamath Hydroelectric Project dams in the upper Klamath Basin. Entrainment is difficult to quantify because of limited data and the high degree of environmental variability, which especially affects annual variations in larval production. Thus, this analysis is based on the best available scientific information with appropriate assumptions being made, as described below.

A quantification of effects to LRS and SNS based on field measurements at each facility was unavailable for most of PacifiCorp's Project (USFWS 2007), so it was necessary to make assumptions about effects, as described below. The primary assumptions used in our analysis are: (1) entrainment is directly proportional to flow (i.e., as flow through facilities increases so does entrainment); (2) turbine mortality = 25 percent of suckers passing through the turbines; (3) spillway mortality = 2 percent of suckers passing through the spillway gates; and (4) 90 percent of suckers entering most reservoirs (exception being Copco No. 2) remained in those reservoirs rather than dispersing downstream; other assumptions are described below. The basis for these assumptions was described in the 2007 FERC biological opinion (USFWS 2007).

Larval Suckers –Annual Turbine and Spillway Mortality

Link River Facilities. Facilities at the upper Link River near the outlet of Upper Klamath Lake (UKL) include the A Canal and the Link River Dam, both owned by Reclamation; and the East Side flow line, the West Side power canal, and their associated power houses, owned by PacifiCorp. Larval sucker entrainment was measured in the late 1990s at the Link River Dam by Gutermuth et al. (2000a, b) and in 2012 by Simon et al (2013). Based on entrainment studies in the Link River by Simon et al. (2013), approximately 4.9 million (confidence limits = 0.7 to 12.1 million) sucker larvae were entrained into the Link River in May and June 2012. This season represents the major period for larval entrainment based on previous studies by Gutermuth et al. (2000a, b). This estimate included entrainment of larvae at the spillway gates that are part of the dam as well as at the East Side and West Side facilities operated by PacifiCorp. Based on flow data for the recent past up to 2007, approximately 60 percent of the flow in the April-July larval period passed through the East Side and West Side facilities, and 40 percent passed through the spillway gates in the dam (USFWS 2007). Using these flow proportions and the 2012 entrainment data for the Link River, we estimate that 1.9 million larval suckers are entrained at the spillway gates in the dam per year, where an estimated 38,995 or 2 percent die from trauma. Of the 2.9 million sucker larvae that are estimated to be entrained at the East Side flow line and West Side power canal, an estimated 731,161, or 25 percent, die as a result of turbine mortality, as discussed below (Table A1). Consequently, of the estimated 4.9 million larvae entering the Link River annually from UKL, an estimated 4.1 million larvae enter Keno Reservoir alive.

Table A1. Estimated annual sucker mortality at Link River Dam, East Side and West Side facilities, and the Klamath River hydropower facilities below Keno due to turbines, spillways, and flow lines.

	Facility							
Life Stage	Link River	East Side + West Side	Keno	J.C. Boyle	Copco No. 1	Copco No. 2	Iron Gate	Total
	Turbine Mortality							
Larvae	0	731,161	0	9,452	13,268	9,951	731	764,563
Juveniles	0	0	0	77	6	5	1	89
Adults	0	4	0	0	0	0	0	4
	Spillway and Flow line Mortality							
Larvae	38,995	0	8,208	48	0	0	1	47,252
Juveniles	594	66 ^A	65	0	0	0	0	725
Adults	1	0	0	0	0	0	0	1
	Total Mortality							
Total	39,590	731,231	8,273	9,577	13,274	9,956	733	812,634

A. The estimate for juvenile spillway mortality at the East Side and West Side facilities is based on estimated mortality due to passage through the East Side flow line, which is assumed to be 2 percent. Under current operations, East Side and West Side turbines are taken offline during the August – October peak entrainment period for juveniles as explained in the text, but 80 cfs flow passes through the flow line.

Keno Facilities. We estimated that 10 percent of larval suckers entering Keno Reservoir from the Link River are entrained at Keno Dam and the remaining 90 percent would be accounted for by either: (1) natural mortality, (2) entrainment at other diversions in Keno Reservoir, or (3) suckers that take up residence in the impoundment (USFWS 2007). Thus of the estimated 4.1 million sucker larvae entering the Keno Reservoir alive, an estimated 410,000 are entrained at the Keno Dam per year. Although Keno Dam does not have turbines, fish moving downstream must pass through the spillway gates, a fish ladder, sluice conduit, or auxiliary water supply; some mortality is likely to occur (USFWS 2007). Annual mortality rates through these structures are assumed to be 2 percent of the larvae entrained, which equals 8,208 larvae (Table A1). Based on this assumption, we estimate that approximately 402,000 larvae move downstream alive to the J.C. Boyle Reservoir per year.

J.C. Boyle Facilities. We estimated that 10 percent of the sucker larvae entering J.C. Boyle Reservoir from Keno Reservoir are entrained at J.C. Boyle Dam. Based on flow data provided by PacifiCorp for the years 1994-2011, an average of 94 percent of the flow passed through the turbines in June, when most larvae were entrained (Gutermuth 2000a), and 6 percent passed over the spillway. Therefore, of the 402,000 larvae entering J.C. Boyle Reservoir, we estimate that 40,200 reach the J.C. Boyle Dam and are entrained, including 37,800, or 94 percent, passing through the turbines and 2,400, or 6 percent, going over the spillway. Although the J.C. Boyle

Dam has fish screens for the turbines, we consider them ineffective at excluding small larval suckers (USFWS 2007). Annual mortality is estimated at 9,452 (or 25 percent) larvae from the turbines and 48 (or 2 percent) from the spillway. Of the larval suckers passing the J.C. Boyle facility, we assume that 30,700 move downstream alive per year.

Copco No. 1 Facilities. Of an estimated 30,700 larval suckers dispersing downstream of J.C. Boyle Dam, we assumed 10 percent (3,100) reach Copco No. 1 Dam (USFWS 2007). Additionally, based on evidence of SNS spawning in the Klamath River just upstream from Copco Reservoir and larval drift estimates in this reach (Beak Consultants Inc. 1987), we estimate that 500,000 larvae are produced upstream of the reservoir annually owing to sucker spawning that occurs there (USFWS 2007). An estimated 10 percent (50,000) of these larvae disperse through Copco Reservoir to the dam. Thus the total number of larvae reaching the dam is 53,100. Based on the data provided by PacifiCorp, 100 percent of the flow at Copco No. 1 Dam in June passes through the turbines and 0 percent through the spillway. Of the total 53,100 sucker larvae that are entrained at Copco No. 1 Dam, all go through the turbines and none pass over the spillway. Larval mortalities through the turbines are estimated to be 13,268 larvae or 25 percent per year (Table A1). Of the larval suckers passing the Copco No. 1 facility, we estimate that 39,800 move downstream alive per year.

Copco No. 2 Facilities. Because Copco No. 2 Dam is only 0.3 miles below Copco No. 1 Dam, water residence time is less than 1 hour; therefore we assumed that all sucker larvae entering the small reservoir reach the Copco No. 2 Dam (USFWS 2007). Of the 39,800 larval suckers passing Copco No. 2 Dam annually, all are entrained through the turbines. Annual, turbine mortality is estimated to be approximately 9,951 larval suckers (Table A1). Of the larval suckers passing the Copco No. 2 Dam, we estimated that 29,900 move downstream alive per year.

Iron Gate Facilities. Of the 29,900 larval suckers entering Iron Gate Reservoir annually, we assume 3,000 larvae, or 10 percent, reach the dam and are entrained into turbines or spillway. Of these, we assume 731 are killed by turbines and 0 from the spillway per year. Because there is no suitable habitat for LRS and SNS downstream of Iron Gate Dam, we assume all of the larvae that survived passage through the dam will die in the river downstream of Iron Gate Dam.

Summary of Larval Turbine and Spillway Mortality

We estimate that 811,815 larval suckers per year die as a result of turbine, spillway, and flow-line injuries at the Link River Dam, East Side and West Side facilities, and at the five Klamath River facilities owned by PacifiCorp (Table A1).

2.0 Juvenile Suckers - Annual Turbine and Spillway Mortality

Link River Facilities. Based on estimates of juvenile entrainment by Gutermuth et al. 2000a, b) and factoring in the 80 percent decline in adult suckers in UKL, we estimate that approximately 33,000 juveniles move downstream to the Link River Dam each year from the lake and are entrained. PacifiCorp, in an effort to minimize entrainment of LRS and SNS, has not operated the turbines at the East Side and West Side facilities since 2008 during the juvenile sucker entrainment period from August through September; however, approximately 80 cfs moved through the East Side flow line. Using that information and estimates of total flow in the Link

River, we determined that about 10 percent of the total Link River flow passed through the flowline in the August-September period when juvenile suckers are most likely to be entrained. Based on this, we estimate that 3,300 juveniles passed through the East Side flow line and 29,700 (approximately 90 percent) through the spillway gates, fish ladder, and auxiliary water structures at the dam. Mortality through these facilities is assumed to be 2 percent, or 594 at the dam and 66 at the East Side facility (Table A1). Thus, of the estimated 33,000 juvenile suckers that are entrained at the dam each year, 660 are likely to die from injuries passing the Link River Dam spillways and the East Side flow line, and 32,340 moved downstream alive to the Keno Reservoir per year.

Keno Facilities. We estimate that 3,234, or 10 percent, of the estimated 32,340 juvenile suckers entering Keno Reservoir make it downstream alive to the Keno Dam. We also assumed mortality equals 2 percent (or 65) of the juvenile suckers passing through the spillway gates, fish ladder, auxiliary water supply, or sluice conduit (Table A1). Because Keno Dam lacks turbines, no turbine mortality of the juvenile suckers occurs there. Of the juvenile suckers passing the Keno Dam, we estimate that 3,169 disperse downstream alive per year.

J.C. Boyle Facilities. We assumed 317, or 10 percent, of the 3,169 juvenile suckers entering J.C. Boyle Reservoir make it to the dam. Of these, 307, or 97 percent, pass through the turbines and 10, or 3 percent, pass through the spillway, based on flow data from PacifiCorp for August and September when juvenile entrainment is highest (Gutermuth et al. 2000a). With mortality rates of 25 percent and 2 percent, respectively, we estimate that annual the turbines cause 77 deaths and spillways cause 0 deaths annually (Table A1). Of the juvenile suckers passing the J.C. Boyle facility, we estimate that 240 disperse downstream to Copco No. 1 Reservoir annually.

Copco No. 1 Facilities. Of the 240 juvenile suckers entering Copco No. 1 Reservoir, we assume 24, or 10 percent, reach the dam. Of these, 24, or 100 percent, pass through the turbines and 0 percent pass through the spillway, based on flow data provided by PacifiCorp. With an estimated turbine mortality rate of 25 percent, we estimate annual turbine mortality of 6 suckers at the Copco No.1 Facilities (Table A1). Of the juvenile suckers passing the Copco No.1 facility, we estimate that 18 move downstream each year.

Copco No. 2 Facilities. We estimate that all juvenile suckers (18) entering the Copco No. 2 Reservoir make it to the Copco No. 2 Dam because of the small size of the reservoir. Of these, we assume 100 percent pass through the turbines and 0 percent through the spillway. With a turbine mortality rate of 25 percent, we estimate annual turbine mortality of 5 suckers (Table A1). Of the juvenile suckers passing the Copco No. 2 facility, we estimate that 14 move downstream each year.

Iron Gate Facilities. An assumed 10 percent (1) of the 14 juvenile suckers entering Iron Gate Reservoir make it to the dam and dies from injuries as a result of collisions with turbines.

Summary of Juvenile Turbine and Spillway Mortality

We estimated that total juvenile sucker mortality resulting from turbine and spillway trauma at the Link River Dam and East Side and West Side facilities, plus PacifiCorp's five Klamath River facilities is 814 per year (Table A1).

3.0 Adult/Sub-adult Suckers - Annual Turbine and Spillway Mortality

Link River Facilities. Before the A Canal was screened, the highest number of sub-adult/adult LRS and SNS entrained at the East Side and West Side power diversions during a non-die-off year was 14 in 1998 (Gutermuth et al. 2000a, b). We estimate that an additional 20 percent of this amount was entrained through Link River Dam spillway gates, fish ladder, and auxiliary water supply based on the relative volume of flow through the Link River (4 fish). Gutermuth et al. (2000a) estimated 411 sub-adult/adult (adults) LRS and SNS were entrained at A Canal in 1998. Because UKL sucker populations have declined by an estimated 80 percent since adult sucker entrainment was last measured, we assume that entrainment of adult suckers has declined by 80 percent. With the screening of the A Canal, all adult suckers that get past the head works and reach the fish screen are bypassed back into the Link River above the dam. We assumed that 50 percent of these fish go back to UKL and 50 percent are entrained at Link River Dam (USFWS 2007). Thus, an estimated 40 adult suckers move down to the Link River Dam annually and are entrained. Of these, we assume 50 percent would pass through the turbines and 50 percent through the spillway; however, because PacifiCorp shuts down the East Side and West Side facilities during the August-October period, when about one-half of the adult sucker entrainment occurred (Gutermuth et al. 2000a), we assume this adjustment leads to 25 percent of adult suckers (10) being entrained into the East Side and West Side facilities and 75 percent (31 suckers) moving through the spillway. We estimate annual turbine mortality at 25 percent (4 adults) and spillway mortality at 2 percent (1 adult; Table A1). Of the adult suckers passing the Link River Dam annually, we estimate that 35 adult suckers move downstream alive each year.

Keno to Iron Gate Facilities. Based on the low numbers of adult suckers estimated to have been entrained at the Link River Dam and associated East Side and West Side hydropower facilities (40), we estimate that no adult suckers were likely taken each year by the Project hydroelectric facilities between Keno Dam and Iron Gate Dam (Table A1).

Summary of Larval, Juvenile, and Adult Sucker Turbine and Spillway Mortality

Of the estimated 4.9 million sucker larvae, 33,000 juveniles, and 40 sub-adult/adults that are entrained at Link River Dam and the East Side and West Side facilities each year, we estimate that approximately 812,000 larvae, 813 juveniles and 5 adult LRS and SNS die as a result of injuries received from turbines and spillways (Table A1). Of the suckers that enter the reservoirs and are not killed by turbines or spillways, many also likely die from other causes including stranding, as discussed below (USFWS 2007, 2008; NMFS and USFWS 2013).

4.0 Effects of Stranding and Ramp Rates at Dams and Reservoirs

Hydroelectric facilities typically have the capacity to increase or decrease flows downstream of the facilities; the rate at which these changes occur is called the “ramp rate” or “ramping.” Project ramping occurs when power generation operations require an increase or decrease in flow through the turbines for shifts in power demand or for other reasons. Ramping occurs during Project drawdown and when outflow is reduced to facilitate reservoir refill. Ramping can also occur when maintenance activities require lower reservoir levels to provide access to

structures. Unplanned outages are an uncontrollable cause of Project ramping. Project start-up after planned and unplanned outages also involves ramping.

Sudden flow changes in stream reaches due to Project ramping can adversely impact fish. Significant rapid flow reduction in bypassed, peaking, and regulated reaches affects a fish by dewatering spawning, rearing, or foraging habitat, which strands fish. Rapid flow increases in bypassed, peaking, and regulated reaches can wash out existing spawning areas, displace fry, and displace macro-invertebrates, which are food for fish in these reaches.

Link River Dam Facilities. Sucker larvae are considered vulnerable to stranding because of their poor swimming ability, small size, and limited shoreline orientation (USFWS 2007). However, there is no information on the extent of larval stranding in the Link River. Nevertheless, considering that large numbers of larvae disperse through this reach, stranding mortality was estimated at up to 5,000 sucker larvae each year during down ramping (USFWS 2007). With up to tens of thousands of juvenile suckers dispersing downstream through Link River Dam spillway, we estimated up to 500 could be stranded per year (USFWS 2007). We do not believe that sub-adult/adult suckers are stranded because they have not been reported in previous spillway termination salvage efforts and they tend to occupy deeper areas that are not prone to dewatering (USFWS 2007). With declines in the abundance of adult suckers in UKL amounting to 80 percent over the past decade (NMFS and USFWS 2013), we assume that this take has been reduced by 80 percent and is equal to 1,000 larvae and 100 juveniles per year (Table A2).

No adult suckers are anticipated to be affected by stranding, ramping, or reservoir fluctuations because they are more likely able to avoid such conditions.

TABLE A2. Estimates of sucker mortality due to stranding and reservoir fluctuations at the Link River Dam and operations at the five Klamath River Project facilities.

Life Stage	Facility						Total
	Link River Dam	Keno Dam	J.C. Boyle Dam	Copco No. 1 Dam	Copco No. 2 Dam	Iron Gate Dam	
Stranding and Ramp Rate Effects							
Eggs	0	0	10,000	0	0	0	10,000
Larvae	1,000	400	1,000	0	20	0	2,420
Juveniles	100	20	5	50	0	0	175
Adults	0	0	0	0	0	0	0
Reservoir Fluctuations							
Larvae	0	0	2,000	200	0	100	2,300
Juveniles	0	0	200	0	0	0	200
Adults	0	0	0	0	0	0	0
Total	1,100	420	13,205	250	20	100	15,095

Keno Dam. PacifiCorp has implemented a voluntary ramp rate below Keno Dam of 500 cfs or 9 inches per hour (PacifiCorp 2004). Project impacts result from periodic low flows in combination with a high down ramp rate (Tinniswood 2006). Under current conditions, the Service estimates that up to 400 larvae and 20 juveniles could be killed annually due to stranding below Keno Dam, based on estimates of suckers passing through the Keno Reach identified in the previous section on entrainment.

J.C. Boyle Dam. The FERC license, as continued through current annual licenses, requires PacifiCorp to ramp up and ramp down flows in the J.C. Boyle Bypassed Reach at a rate of less than 9 inches per hour (about 700 cfs). While fish stranding and mortality events due to down ramping are less common in the J.C. Boyle Bypassed Reach due to the relatively constant flow of 100 cfs below J.C. Boyle Dam an additional 220 to 250 cfs of spring flow accruing in the upper mile of the bypassed reach, and the rarity of down ramping events (mostly during February through May), occasional fish die-offs occur due to high down ramp rates (Oregon Department of Fish and Wildlife [ODFW] 2006). No LRS or SNS have been reported from these events; however, fish die-offs are also less obvious at this location because river reaches below J.C. Boyle Dam have more remote access.

The current FERC ramp-rate requirement for the J.C. Boyle Peaking Reach is 9 inches per hour. Current rates of stage decline are generally between 5 and 9 inches per hour (PacifiCorp 2004). In the J.C. Boyle Peaking Reach (10 study sites), PacifiCorp observed no fish stranded in 2002 and six fish stranded in 2003, including one juvenile sucker (PacifiCorp 2004). However, examination of isolated pools and side channels found trapped larval suckers (USFWS 2007). Therefore, we estimate that 10,000 sucker eggs, 1,000 larvae, and 5 juveniles are stranded due to operational changes in flows below J.C. Boyle Dam per year (Table A2).

Copco No. 1 and No. 2. There are also ramp rate impacts to SNS that ascend from Copco Reservoir to spawn in the lower portion of the peaking reach (Beak Consultants Inc. 1987). Flows in this reach that are affected by peaking operations result in wide daily fluctuations ranging from about 350 to 3,000 cfs. Beak Consultant Inc. (1987) identified that approximately 10 percent of the Klamath River between Copco Reservoir and the Oregon/California border was composed of areas subject to stranding of larvae at low flows.

Ramp rate effects on listed suckers below Copco No. 1, Copco No. 2, and Iron Gate Dams are unknown. However, because there is no riverine habitat between Copco No. 1 and Copco No. 2 and water levels rarely fluctuate more than a few inches, stranding potential below Copco No. 1 is minimal. However, since sucker larvae are fairly common in Copco No. 1 Reservoir, some downstream dispersal and stranding likely occurs below Copco No. 2 in the bypassed reach. Ramping of flows in the bypassed reach is infrequent and occurs only when maintenance requires spill at the dam, during a forced outage, or when inflows are greater than the hydraulic capacity of the powerhouse. Because there are low numbers of suckers below Copco No. 1 Dam, only a small number of suckers are affected. We estimate that 20 sucker larvae are adversely impacted below Copco No. 2 Dam by stranding (Table A2).

Because endangered suckers are rare in Iron Gate Reservoir and few suckers disperse below the dam, current operation of the Iron Gate development likely results in no measurable stranding and mortality of larval, juvenile, and sub-adult/adult suckers (USFWS 2007). Furthermore, any LRS and SNS that are released into the Klamath River below the Iron Gate Dam are considered lost because there is no suitable lake habitat downstream.

5.0 Effects of Reservoir Fluctuations

Keno Reservoir. An agreement between PacifiCorp and Reclamation specifies that the maximum water surface elevation of Keno Reservoir should be at 4,086.5 feet and the minimum water surface elevation should be at 4,085 feet. However, at the request of irrigators who divert water from the Keno Reservoir, PacifiCorp generally operates Keno Dam to maintain the reservoir with 0.1 feet of elevation 4,085.4 from October 1 to May 15 and with 0.1 feet of elevation 4,085.5 from May 16 to September 30 to allow consistent operation of irrigation canals and pumps located along the reservoir. Because Keno Dam is operated to maintain a nearly constant reservoir level, there is little potential for fish stranding. However, once a year, at the request of irrigators, PacifiCorp draws the reservoir down about 2 feet over a period of 24 hours (with a drawdown rate of less than 1 inch per hour) for 1-4 days in March or April, so that irrigators can conduct maintenance on their pumps and clean out their water withdrawal systems before the irrigation season. It is unlikely that suckers are stranded by these drawdowns because few larvae would be present at that season and juvenile and adult suckers occupy deeper water where they would not be vulnerable to stranding.

J.C. Boyle Reservoir. While the J.C. Boyle Reservoir can operate within a range of 5.5 feet, the reservoir generally fluctuates 1-2 feet per day and at a rate of elevation change of up to 2 inches per hour. At these rates there is little opportunity for fish stranding except for larval suckers that are poor swimmers. More importantly, larval and juvenile suckers using the shallow shoreline habitats may be temporarily displaced on a daily basis. Predation by non-native fish species on larval and juvenile suckers likely occurs as a result of reservoir fluctuations that displace fish from shoreline cover habitat, making them more vulnerable to predation. As a result, we estimate that 2,000 sucker larvae and 200 juvenile are killed as a result of fluctuating water levels in J.C. Boyle Reservoir (Table A2).

Copco No. 1 and No. 2 Reservoirs, and Iron Gate Reservoir. Copco No.1 and Iron Gate Reservoir water levels are normally maintained within 6.5 feet and 4 feet of full pool, respectively, and average daily fluctuations are less than 0.5 feet (less than 1 inch per hour; FERC 2006). However, maximum daily fluctuations up to 3.0 feet occur on rare occasions. Although thousands of sucker larvae were collected in Copco No. 1 Reservoir (Desjardins and Markle 2000), because of the small daily water level fluctuations and the lack of shallow shoreline habitat with gradual slopes, the Service estimated that up to 200 larval suckers are stranded and die per year in Copco No. 1 Reservoir (Table A2). Because water levels in Copco No. 2 Reservoir change little we did not anticipate mortalities.

Catches of larval suckers in Iron Gate Reservoir in 1998 and 1999 were about 15 percent lower than catches in Copco Reservoir. Therefore, based on the relatively small numbers of larval suckers collected by Desjardins and Markle (2000), the generally steep shorelines, and the small

daily water level fluctuations, the estimated number of larval sucker stranded is 100 (Table A2;); USFWS 2007). No juvenile and sub-adult/adult suckers are likely stranded because they are generally located in deeper water and have better swimming ability to escape shallow water (USFWS 2007). Because of the small daily reservoir fluctuations and lack of emergent vegetation habitat providing cover for larval and juvenile suckers in Copco No. 1 and Iron Gate Reservoirs, we do not believe there are increased predation impacts due to habitat displacement.

Based on our analysis of effects from accidental changes in ramp rates that strand suckers and normal reservoir fluctuations that arise from daily operations at the Link River and Keno Dams, and the four downstream hydro-facilities, we estimated that annual mortality rates are approximately 10,000 eggs, 4,700 larvae, and 375 juveniles (Table A2). We do not anticipate adverse effects to adult suckers from flow and reservoir level changes because adults occur in deeper water and are better able to avoid these fluctuations.

6.0 Summary of Mortalities from Operations of All Dams and Hydropower Facilities

Based on the analysis presented above, the mortality of LRS and SNS life stages resulting from the operations of all 8 dam and hydropower facilities is shown below in Table A3. Annual mortality of all sucker life stages at the 8 facilities, Link River Dam to Iron Gate Dam, is approximately 828,000, with 99 percent being eggs and larvae. Few adult suckers are likely affected as shown in the table.

Table A3. Estimated annual sucker mortality at Link River Dam, East Side + West Side, and the five Klamath River facilities due to turbines, spillway, flow lines, ramping rate effects and reservoir fluctuations.

Life Stage	Facility							Total
	Link River	East Side + West Side	Keno	J.C. Boyle	Copco No. 1	Copco No. 2	Iron Gate	
Eggs	0	0	0	10,000	0	0	0	10,000
Larvae	39,995	731,161	8,608	12,500	13,468	9,971	832	816,535
Juveniles	694	66	85	282	56	5	1	1,189
Adults	1	4	0	0	0	0	0	5
Total	40,690	731,231	8,693	22,782	13,524	9,976	833	827,729

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