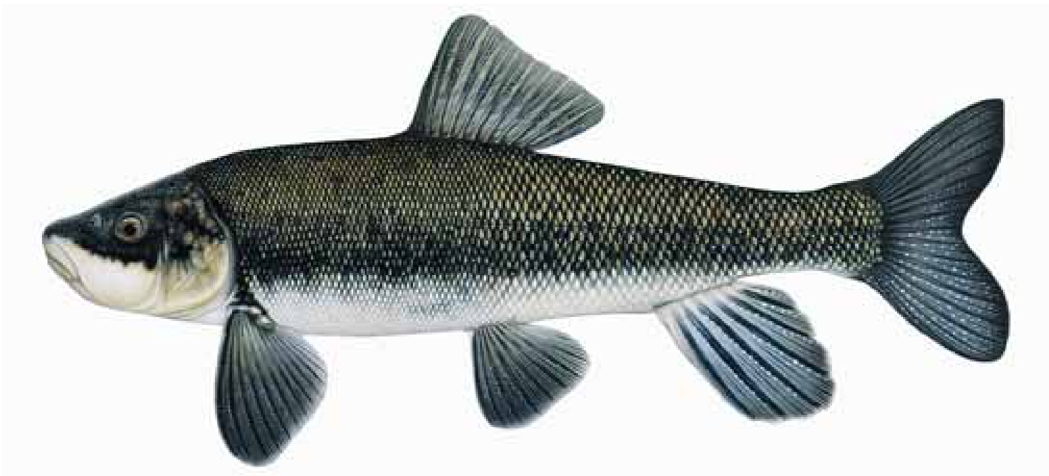
Shortnose Sucker (*Chasmistes brevirostris*)
5-Year Review
Summary and Evaluation



Shortnose Sucker by J. Tomelleri

U.S. Fish and Wildlife Service
Klamath Falls Fish and Wildlife Office
Klamath Falls, Oregon

July 2007

5-YEAR REVIEW
Shortnose Sucker (*Chasmistes brevirostris*)

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LIST OF ACRONYMS AND ABBREVIATIONS

AFA	*Aphanizomenon flos-aquae*
CNO	California/Nevada Operations Office
CPUE	catch per unit effort
CWA	Clean Water Act
DO	dissolved oxygen
DPS	distinct population segment
ESA	Endangered Species Act
ERO	Ecosystem Restoration Office, USFWS
FR	Federal Register
IMST	Independent Multidisciplinary Science Team
ISRP	Independent Scientific Review Panel
KBEF	Klamath Basin Ecosystem Foundation
KBRT	Klamath Basin Rangeland Trust
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NRC	National Research Council
NRCS	Natural Resources Conservation Service
ODEQ	Oregon Department of Environmental Quality
SNS	shortnose sucker
TMDL	total maximum daily load
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

5-YEAR REVIEW
Shortnose Sucker (*Chasmistes brevirostris*)

1.0 GENERAL INFORMATION

1.1. Reviewers

Lead Regional Office: Mary Grim, California Nevada Operations, 916-414-6464

Lead Field Office: Curt Mullis, Klamath Falls FWO, 541-885-8481

1.2. Methodology used to complete the review

This review was prepared as a joint effort between the U.S. Fish and Wildlife Service (Service) Klamath Falls Field Office and California Nevada Operations Office. In 2004, we published a Federal Register notice (69 FR 43554) requesting information about the status of the shortnose sucker (*Chasmistes brevirostris*) (SNS). No information was received.

In 2005, we convened a panel of scientists familiar with the SNS to provide input on the biology of and threats to the fish. This "Independent Scientific Review Panel" (ISRP), consisted of 12 scientists representing stakeholders, including the Klamath Tribes; the water-user community; conservation/recreation groups; the States of California and Oregon; and Federal agencies, including the Bureau of Reclamation (USBR), U.S. Geological Survey (USGS), and the Service. Key topics covered during the ISRP workshops included sucker population dynamics; taxonomy; genetics; status of threats, especially water quality; and progress towards recovery (ISRP *in litt*. 2005). Information discussed during these workshops and provided by the ISRP members was considered during the preparation of this review.

In October 2005, a status recommendation was developed by a panel of Service scientists and resource managers. USGS scientists familiar with the species were present to provide technical expertise, but they did not specifically participate in making the recommendation. In a structured decision-making process, the panel reviewed the administrative record, including notes of discussions by and opinions of members of the ISRP. The Service panel made a status recommendation to the California/Nevada Operations Office (CNO) Manager. This document reflects those discussions.

1.3. Background

1.3.1. FR Notice announcing initiation of this review

A Federal Register notice was published on July 21, 2004 (69 FR 43554) and initiated a 60-day request for information.

1.3.2. Listing history

Original Listing:

FR notice:	53 FR 27130
Date listed:	July 18, 1988
Entity listed:	Species
Classification:	Endangered

1.3.3. Associated rulemakings

Critical habitat was proposed in 1994 (59 FR 61744), but not finalized.

1.3.4. Review history

Although we have tracked the status of the SNS and evaluated threats in the context of recovery plan development and biological opinions, no comprehensive status review (e.g., 12-month finding, 5-year review, or reclassification rule) has been completed.

1.3.5. Species' recovery priority number at start of 5-year review

Shortnose sucker has a recovery number of 8c. This number indicates a species that has a high degree of threats and a high recovery potential. The "c" indicates that the species is in conflict with construction or other development projects or other forms of economic activity.

1.3.6. Recovery Plan or Outline

Name of Plan:	Lost River (*Deltistes luxatus*) and shortnose (*Chasmistes brevirostris*) suckers recovery plan.
Date issued:	March 17, 1993.
Previous revisions:	None

2.0 REVIEW ANALYSIS

2.1. Application of the 1996 Distinct Populations Segment (DPS) policy

2.1.1. Is the species under review a vertebrate?

_X_ Yes
___ No

2.1.2. Is the species under review listed as a DPS?

___ Yes
_X_ No

2.1.3. Is there relevant new information for the species regarding the application of the DPS policy?

___ Yes
_X_ No

2.2. Biology and Habitat

Since listing, considerable new information has been obtained on physical, chemical, and biological conditions in Upper Klamath Lake affecting the SNS. Some of this work, mostly fish monitoring, uses technologies employed for decades in fishery investigations, but the data are being analyzed in new ways that improve the reliability of the results. These new tools are providing information that was unavailable when the species was listed in 1988, or when the recovery plan was developed in 1993. Information relevant to the status of SNS is summarized below.

2.2.1. Background

Shortnose suckers are distinguished by their large heads with oblique, terminal mouths with thin but fleshy lips. The lower lips are deeply notched. They are dark on their back and sides and silvery or white on the belly. They can grow to about 50 cm, but growth is variable among individuals (Moyle 2002). Shortnose suckers have been recorded to live as long as 33 years (Moyle 2002).

Adult and juvenile SNS prefer shallow, turbid, and highly productive lakes that are cool, but not cold, in summer (generally 15 to 25° C), have adequate dissolved oxygen (DO) (above 4 mg/l), and are moderately alkaline (Moyle 2002).

Shortnose suckers grow rapidly in their first five years, reaching sexual maturity sometime between years four and six. The majority of SNS spawning occurs from early April to early May in the larger tributaries of inhabited lakes. River spawning habitat is riffles or runs with gravel or cobble substrate, moderate flows, and depths of 11-130 cm. Historically, SNS have been noted to spawn in lakes, particularly at springs occurring along the shorelines (Moyle 2002), although currently few SNS spawn along shorelines (Barry et al. 2007). Shortnose suckers can spawn multiple times during their life. It is unknown if an individual fish will spawn multiple times in a single year or if an individual will spawn every year (NRC 2004).

Eggs incubate in the gravels for approximately two weeks. The larvae emerge sometime in April to early June and most immediately move downstream to lakes (Cooperman and Markle 2003). During their first year, suckers are known as age-0 fish. While in streams, larvae prefer shallow slack water areas along streambanks. In Upper Klamath Lake, they prefer shallow water that is vegetated (Cooperman and Markle 2004), but in Gerber Reservoir and Clear Lake rearing occurs shallow, unvegetated areas.

2.2.2. Distribution

At the time of listing, the SNS was reported from Upper Klamath Lake and its tributaries (Klamath Co., Oregon); from the Lost River (Klamath Co., Oregon, and Modoc and Siskiyou Co., California) and Clear Lake (Modoc Co., California); the Klamath River above Keno (Klamath Co., Oregon); and in one or more of the Klamath River reservoirs below Keno (Klamath Co., Oregon, and Siskiyou Co., California) (Figure 1) (USFWS 1988).

The known geographic range of SNS has not substantially changed since listing and is still found primarily in Upper Klamath Lake and Clear Lake. Two previously-unreported SNS populations have been found since listing. A population of a few hundred adults occurs in the Tule Lake sumps at the terminus of the Lost River (Siskiyou Co., California) (Scoppettone et al. 1995). Also, SNS are now known to occur in Gerber Reservoir (Klamath Co., Oregon), which was considered in 1994 when the Service proposed critical habitat (59 FR 61744). New genetics information casts some doubt on whether these fish in Gerber Reservoir and Clear Lake are actually SNS (ISRP *in litt*. 2005; Tranah and May 2006). Until that information can be further evaluated, for the purposes of this review, we will continue to assume that these fish are SNS.

Upper Klamath Lake is a large natural lake located in Klamath County, Oregon. In 1921, its water levels were modified by the construction of Link River Dam (NRC 2004). The watershed occupies about 3,800 square miles, ranges in elevation from 4,100 to over 9,000 feet, and has an average annual precipitation of 27 inches (ODEQ 2002). The lake surface area averages about 64,000 acres (USBR 2005b). Its three major tributaries are the Sprague, Williamson, and Wood rivers.

Clear Lake is a natural lake located in Modoc County, California. It is in the 700-square-mile Lost River watershed, which ranges in elevation from approximately 4,500 to 6,100 feet (USBR 1970). Annual precipitation equals about 13 inches. Upstream stock ponds and diversions reduce inflows somewhat, and over half of the annual inflow is lost to seepage and evaporation (USBR 1970). The lake has one major tributary, Willow Creek, where suckers spawn (Scoppettone et al. 1995). The size of Clear Lake was increased by construction of a dam completed by USBR in 1910. During the 65-year period prior to 1970, annual net inflow has fluctuated from 18,000 to 370,000 acre feet (USBR 1970). The lake has never reached its capacity of 450,000 acre feet.

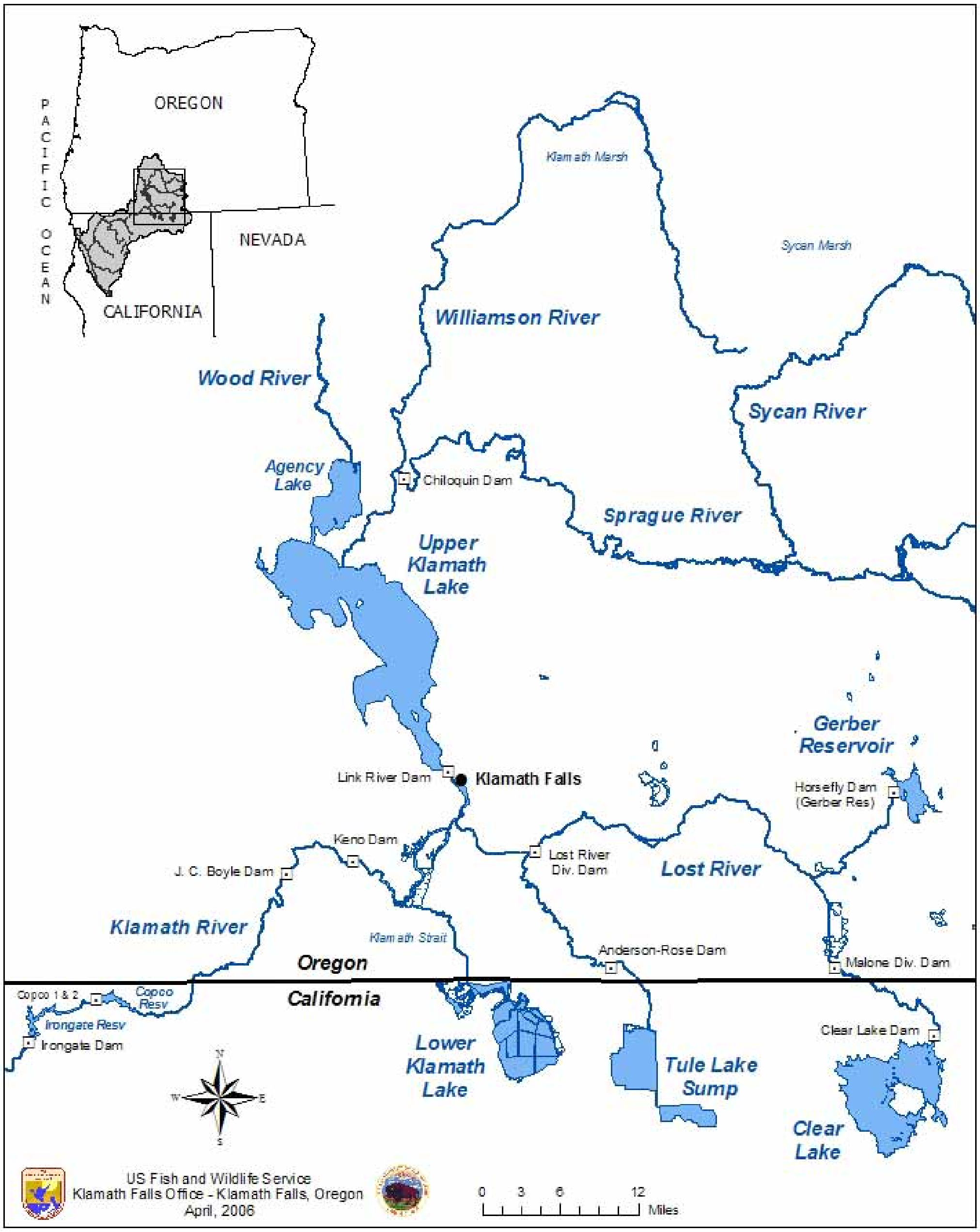

Figure 1. Map of major water bodies in the upper Klamath River Basin.

2.2.3. Abundance

Estimation of fish population size is an inexact science. All estimation methods have limitations caused by environmental conditions or by other factors such as lost tags, timing and geographic range of sampling, unmet statistical assumptions, and broad statistical confidence intervals. Thus, because population size often cannot be precisely estimated, assessment of population trends is used to evaluate the health of fish populations (Shively, pers. comm. 2005). The following discussion is based upon an assessment of SNS population trends.

<u>Population estimates and trends at the time of listing</u>

At the time of listing, the SNS population numbers were unknown, but surveys had shown a general downward trend. In Upper Klamath Lake, surveys in 1984 resulted in an estimate of 2,650 fish and subsequent surveys had reduced catch per unit effort (CPUE), suggesting population reductions had occurred (USFWS 1988). Information gathered in recent years indicates that sucker population estimates made at the time of listing were probably inaccurate. Because assumptions necessary for modeling population size were likely not met, the actual size of the population at that time is uncertain. Available data on distribution of age classes showed that little recruitment (the addition of fish to the reproducing population) had occurred in nearly 18 years because there were few SNS in the population less than 18 years old (USFWS 1988; NRC 2004). Also, substantial threats were present. Thus, the listing was based on a variety of data, all indicating a downward trend (USFWS 1998).

While the population numbers at the time of listing are unknown, the lack of recruitment that was occurring paired with the mortality from the sport fishery and the fish die-offs indicates that the population was declining. On this issue of population trends at the time of listing, the National Research Council (NRC) (NRC 2004) stated:

> "For purposes of ESA actions, the critical facts, which are known with a high degree of certainty, are that the fish are much less abundant than they originally were and that they are not showing an increase in overall abundance."

<u>Recent population estimates</u>

Upper Klamath Lake

As indicated above, estimating the actual size of a fish population is challenging, but trends can be compared using the relative rate of catches from one sampling period to the next using CPUE (Pine et al. 2003). An abundance index based on CPUE data can be useful for measuring general trends, but because they are affected by a variety of factors, CPUE data are less accurate than data obtained by capture-recapture analyses.

Sampling of adult sucker populations is much easier during spawning runs in the Williamson River than in the expanses of Upper Klamath Lake, so comparative adult abundance indices from the Williamson River system are used as an indicator of SNS population abundance and trend in Upper Klamath Lake (Shively, pers. comm. 2005). Based on information obtained in the last two decades, it is evident that sucker populations in Upper Klamath Lake vary considerably in size and age structure, owing to fluctuating recruitment and periodic die-offs (NRC 2004; ISRP *in litt*. 2005).

In 1995, the adult abundance index, which is the cumulative CPUE for the SNS population spawning in the Williamson River system, was over 250 (ISRP *in litt*. 2005; Figure 2). Between 1995 and 1997, the abundance index fell by over 90% (corresponding with die-offs in Upper Klamath Lake), and it declined to approximately 10 by 1999. In 2000 and 2001, recruitment increased and the index moved up to near 40. Since then the index has remained low (Tyler et al. 2004).

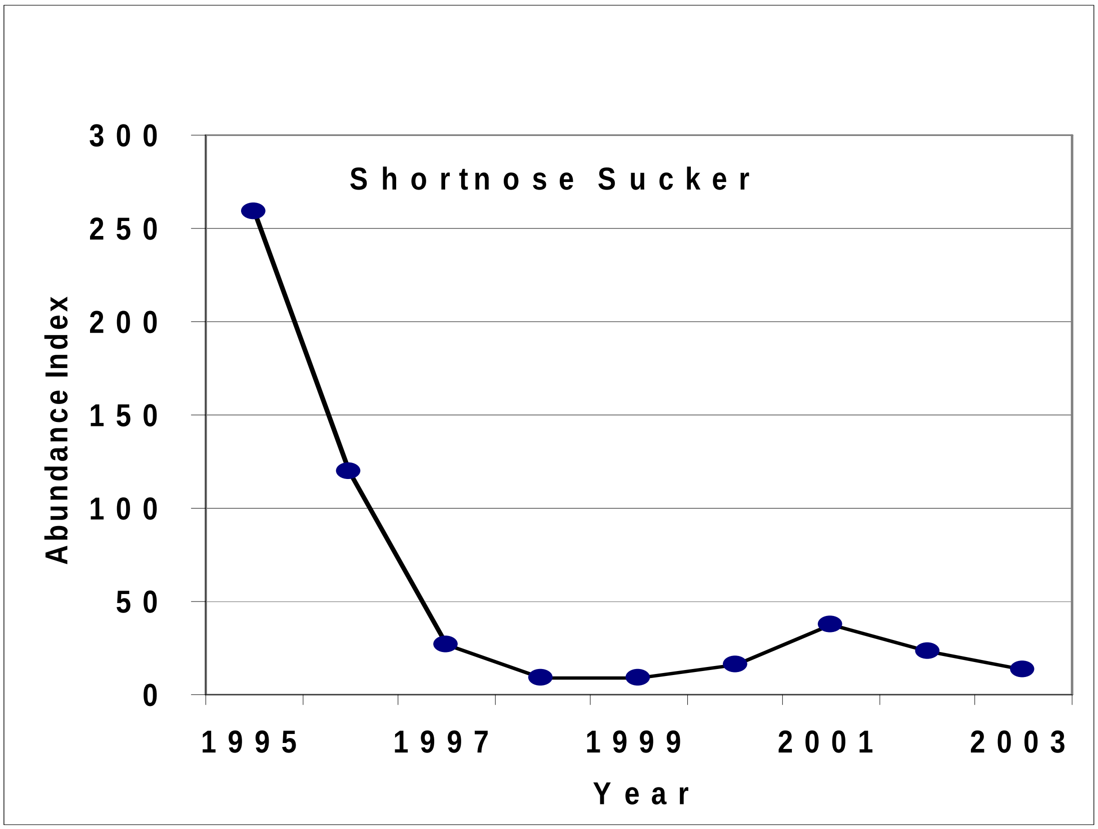

Figure 2. Shortnose sucker abundance index trends in the Williamson River (1995-2003) based on cumulative, mean daily catch per unit effort (USGS data).

Mark-recapture data (where fish are tagged and later recaptured) from 1995 through 2004 have been analyzed to estimate annual survival rates for SNS in Upper Klamath Lake (Figure 3; Janney and Shively 2007). Although adult SNS survival was estimated to be greater than 90% in several years, it was estimated to be less than 70% in half of the years examined. Based upon a mean survival rate of 0.76 for the 1995 through 2004 period, it is estimated that the average life expectancy of SNS after entering the spawning population was only 3.6 years (Janney and Shively 2007). This short estimated life expectancy is of concern because the species is believed to be normally long-lived (up to 30 years); thus suggesting that adults are dying before reproducing often enough for population replacement.

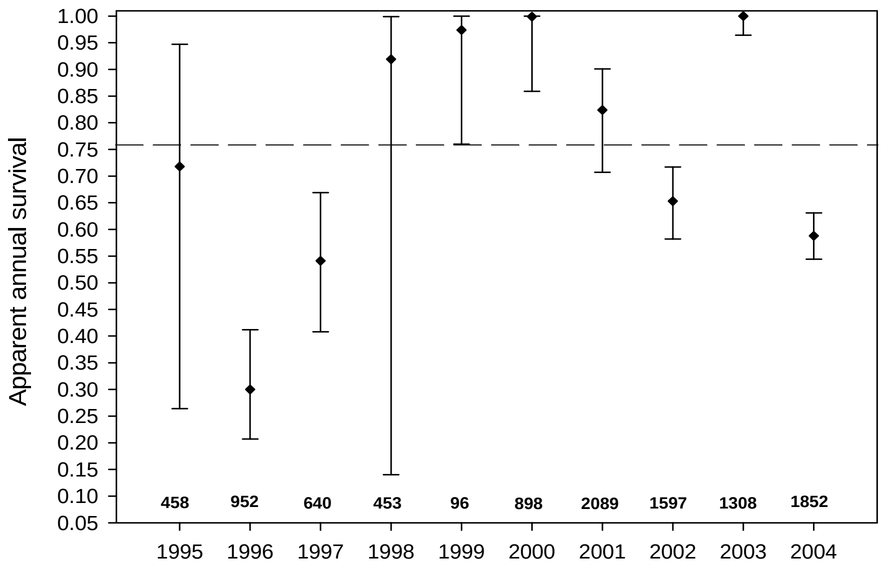

Figure 3. From Janney and Shively (2007). Apparent annual survival rates and 95% confidence intervals for shortnose suckers in Upper Klamath Lake between 1995 and 2004 calculated using capture-recapture data. The numbers presented along the x-axis indicate the sample size captured and released each year. The dotted line represents mean annual survival over the ten year period.

This study also found that no measurable recruitment of SNS in Upper Klamath Lake had occurred from 1997 through 2004 (Janney and Shively 2007). The USGS estimated that the mean rate of population growth during this period was 0.82. A population growth rate below 1.0 indicates a net decline in population size. At the estimated rate, the population could have decreased by nearly 80 percent over the 8 year period (USGS *in litt*. 2007). (However, note that while this estimated result generally corroborates the large decline observed in the CPUE abundance index described above, the abundance index did not indicate a decline of the magnitude observed in the capture-recapture data for 1997-2004. Several factors could explain this discrepancy, including variation in interannual trapping efficiency and age-specific trap susceptibility, but the actual reason for the discrepancy is unknown.) The recruitment and rate of population change for the interval from 2004 – 2005 could not be measured; however, the survival estimate for that period was the lowest observed for a non-fish-kill year (USGS *in litt*. 2007).

Prior to 2006, the last substantial production of age-0 SNS was in the early 1990s. In August 2006, large numbers of age-0 suckers (i.e., suckers in their first year of life) were reported from Upper Klamath Lake and the Sprague River (Parrish, Piaskowski, and Simons, pers. comm. 2006). However, by October 2006, abundance of age-0 suckers had declined to levels similar to what had been observed in previous years (Markle pers. comm. 2007). Because it takes four to six years for this species to sexually mature, 2006 age-0 fish would not be expected to contribute to recruitment until at least 2010; and that eventual contribution is dependent on rates of survival to adulthood. Thus, at best it may be several years until we observe the degree of recruitment of these fish to the breeding population.

Other Reservoirs

Sucker populations in Gerber Reservoir and Clear Lake are showing evidence of frequent recruitment. Sampling of SNS in Clear Lake found a smaller mean size in 2004 and 2005 than in 1993 and 1996. A relatively large number of small fish and a wider overall distribution of sizes were present in 2000 (Barry et al. 2007). These data suggest that there have been declines in the numbers of large adult suckers since 2000 (Barry et al. 2007).

A small population of a few hundred SNS adults occurs in the Tule Lake sumps at the terminus of the Lost River (Scoppettone et al. 1995, Buettner, pers. comm. 2006). It is isolated from upstream spawning areas by a series of dams. A lack of suitable spawning habitat likely prevents this population from being self-sustaining.

2.2.4. Habitat

<u>Spawning and larval habitats</u>

Shortnose suckers use a variety of specific aquatic habitats at various stages in their lives, from larvae to adults. Adult spawning habitats are gravel substrates in streams and rivers. Shortnose suckers are also known to spawn along the lake margins of Upper Klamath Lake, but that currently appears to be a rare occurrence (NRC 2004; Shively, pers. comm. 2005). After hatching, most larvae swim up (emerge) from gravel and quickly emigrate downstream to a lake environment where they occupy “shallow, near-shore, and vegetated” habitats (Cooperman and Markle 2004; NRC 2004).

Researchers have found high densities of larvae in the shallow, littoral (near-shore) areas of Upper Klamath Lake (Buettner and Scoppettone 1990; Klamath Tribes 1996; Markle and Simon 1993; Simon et al. 1995, 1996; Cooperman and Markle 2004; Crandall 2004). Although larval densities as high as 120 larvae/square meter have been reported in emergent vegetation along Upper Klamath Lake, only 2 percent of trawls have densities over 10 larvae /square meter (D. Markle, pers. comm. 2007). Sucker larvae generally occur at higher densities in and adjacent to emergent vegetation than in areas devoid of vegetation (Klamath Tribes 1996; Cooperman and Markle 2004; Crandall 2004). (The term "emergent vegetation" refers to plants that are rooted in lake sediment, with tops extending above the water. Cattails and bulrushes are common examples in the area discussed.) Larvae do not appear to use submerged vegetation as an alternative to emergent vegetation, primarily because submerged vegetation is slow to develop in the spring and therefore is largely not available early in the summer when larvae are present (Cooperman and Markle 2004).

Emergent vegetation along lakeshore areas is believed to be particularly important larval habitat for several reasons. Emergent vegetation provides cover from predators, and also provides habitat for sucker food items such as zooplankton, macroinvertebrates, and periphyton (the community of microscopic organisms that live on submerged surfaces in aquatic environments) (Klamath Tribes 1996; Cooperman and Markle 2004; Crandall 2004; Dunsmoor and Markle 2007). Emergent wetlands also may provide protection from currents and turbulence; and water temperatures can be higher in emergent vegetation so larvae likely grow faster (Crandall 2004).

<u>Juvenile, subadult, and adult habitats</u>

Juveniles suckers use relatively shallow (less than about 1.2 meters), vegetated and un-vegetated shoreline with a variety of substrate types ranging from cobble to mud (Hendrixson et al. *in litt.* 2007). Adult suckers use water depths of 1 to 4.5 meters, but prefer depths of 1.5 to 3.4 meters (Reiser et al. 2001; NRC 2004), and spawn in streams and rivers or lakes, as described above. Sub-adults are assumed to be similar to non-spawning adults in their requirements and habits (NRC 2004).

2.2.5. Genetics

Hybridization was identified as a threat to the SNS at the time of listing (USFWS 1988) and discussions continue about the extent and role of hybridization in SNS evolution and persistence (Markle et al. 2005; Tranah and May 2006). Morphological and molecular genetics studies appear to indicate that hybridization may be occurring between SNS and Klamath largescale suckers (*Catostomus snyderi*) in Gerber Reservoir and Clear Lake, and perhaps in the Lost River (Markle et al.2005; Tranah and May 2006). However, the impact of this hybridization on species conservation is currently unclear and further analysis is warranted (ISRP *in litt*. 2005). Until it is clear that hybridization has progressed to the point that SNS are no longer present in these areas, the Service assumes these fish are SNS.

2.3. Recovery Criteria

2.3.1. Does the species have a final approved recovery plan containing objective, measurable criteria?

No. The Lost River and shortnose sucker recovery plan was issued on March 17, 1993. The plan did not contain specific down-listing or delisting criteria because the Recovery Team found that available information on population dynamics, threats, habitat needs, and other relevant factors was insufficient to develop such criteria. However, interim recovery objectives were developed, as follows: (1) establish secure refuge populations for each unique stock of both species; (2) acquire long-term water rights to ensure water quantities are adequate to support stable populations; (3) ensure water quality is adequate to support stable populations; (4) maintain minimum population sizes so that the species has a reasonable probability of surviving for 200 years; (5) maintain stable age structure showing consistent recruitment with no more than a 4- year gap in recruitment of strong year classes; (6) demonstrate stable or increasing populations for at least 15 years; and (7) ensure habitats support stable populations. Although substantial efforts have been made to achieve recovery (see discussion below), none of the interim objectives have been fully met.

No refuge populations have been established. Shortnose suckers still occur in only two primary populations. Other populations, such as those in the Klamath River reservoirs, are apparently sustaining themselves with the input of larvae or older suckers from other areas (i.e., those in Upper Klamath Lake and Clear Lake).

Low water levels continue to affect sucker habitats, especially in drought years. Ongoing studies funded by USBR have been directed toward providing a better understanding of how Klamath Project management affects suckers. Currently, we lack a clear understanding of the relationship between sucker survival/productivity and lake levels.

Adverse water quality continues to pose a serious threat to suckers in Upper Klamath Lake. Sucker populations have been highly unstable since the recovery plan was prepared, owing to periodic die-offs and infrequent substantial recruitment events.

Finally, considerable progress has been made on habitat restoration, as discussed below, but more is needed because of the amount and degree of degradation. The other interim criteria (i.e., minimum population sizes, stable age structure, and stable or increasing populations) have not yet been met.

2.3.2. Recovery Actions that Reduce Threats to the Lost River Sucker

Through our Ecosystem Restoration Office (ERO) in Klamath Falls, we have been working to recover the SNS since 1993. With our partners, the ERO has supported approximately 400 restoration projects, including 50 wetland and 150 riparian projects.

The cost of these projects has been shared by many partners, including State and Federal programs such as Partners for Fish and Wildlife, Hatfield Restoration, Jobs in the Woods, and Oregon Resources Conservation Act programs, as well as private grant programs and contributions from landowners.

Major habitat restoration projects focusing on suckers have been completed. These include: (1) screening of the main irrigation diversion on the Klamath Project (A-Canal); (2) screening of the outlet at Clear Lake Dam; (3) construction of a new fish ladder at Link River Dam; (4) restoration of over 25,000 acres of wetlands adjacent to Upper Klamath Lake and in the watershed above the lake; (5) 13 fish passage improvement projects, including screening and fish ladders; (6) restoration of the lower 3 miles of the Wood River; and (7) fencing along hundreds of miles of streams (Ross, pers. comm. 2005). Additionally, Chiloquin Dam, a major impediment to upstream migration of the SNS, is planned for removal in 2008 (Korson, pers. comm. 2006). Reconnection of the Williamson River Delta (over 4,000 acres) by 2010 will likely provide significant habitat for endangered suckers (David Evans and Associates 2005).

The Natural Resources Conservation Service (NRCS) has also made a substantial commitment to address water quality/quantity issues in the upper basin. Through authorization and funding for the 2002 Farm Bill, NRCS has restored over 2,200 acres of wetland habitat and conservation of over 6,700 acre-feet of on-farm water. Conservation systems on over 70,000 acres have been planned, and practices have been applied to over 30,000 acres to manage soil, water, air, plants, and animals on private lands (Regan-Vienops, pers. com. 2005).

The Sprague River is listed as water-quality impaired for nutrients, temperature, sediment, and DO under section 303d of the Clean Water Act (ODEQ 2002). The Sprague River is the primary spawning habitat for suckers in Upper Klamath Lake, and the largest tributary to the Williamson River, providing 50% of the inflow to Upper Klamath Lake (NRC 2004). The 2002 Total Maximum Daily Load (TMDL) and water quality management plan developed by the Oregon Department of Water Quality (ODEQ) provides targets and guidance on what needs to be done to improve water quality in the river and Upper Klamath Lake (ODEQ 2002). As a result, many wetland and riparian restoration projects are now designed to improve water quality.

In 2004, the NRC concluded that a lasting resolution of Klamath Basin water issues required an integrated and comprehensive effort (NRC 2004). That is now occurring. For example, representatives of the States of California and Oregon, the President's Klamath River Basin Working Group, and the Environmental Protection Agency have signed the Klamath River Watershed Coordination Agreement. They agreed to place a high priority on their Klamath Basin activities and to coordinate and communicate with one another and with tribal governments, local governments, private groups, and individuals, to resolve water quantity/quality problems in the basin (http://www.doi.gov/news/klamathagreement.pdf).

In 2004, Oregon State University Agricultural Extension Service and the Klamath Watershed Council began a series of monthly meetings with rural landowners in the Sprague River Valley to discuss watershed restoration goals. With the help of the Service, NRCS, the Klamath Basin Ecosystem Foundation (KBEF), and the Klamath Soil & Water Conservation District, this effort has effectively connected landowners with appropriate state and federal resource conservation programs. As a result, more than 70% of the private lands within the Sprague River Valley are partnering with local, state, and federal agencies on land conservation and natural resource actions (Ross, pers. comm. 2005). The efforts of the watershed council and KBEF have resulted in the addition of fiscal partners (e.g., Oregon Department of Agriculture, Klamath County, and Oregon Watershed Enhancement Board) to the conservation partnership. These partnership-forming actions will continue, and will enable more restoration to be done in the future.

The Wood River Valley supplies 25% of the water to Upper Klamath Lake. This valley supports 50% of the cattle in the Upper Basin and is the source of 30% of the external phosphorus loading to Upper Klamath Lake (ODEQ 2002). Due to this nutrient loading, the Wood River Valley was identified by ODEQ as a priority water-quality impaired area. The Klamath Basin Rangeland Trust (KBRT) has been active in the Wood River Valley encouraging landowners to adopt sustainable land and water management practices. Since 2002, 12,000 acres have been enrolled in a program to reduce water use, resulting in a reduction of approximately 1-acre-foot of water per acre of land (Peterson, pers. comm. 2007).

In summary, a number of landowners and agencies are directly or indirectly focused on sucker recovery. The high rates of participation in federal and state conservation programs by ranchers and farmers in the Sprague and Wood river valleys suggests that essential elements of habitat recovery on private land (i.e., voluntary participation and funding) are now in place. This should make it more efficient to conduct restoration in the future. Furthermore, the Service and its partners are committed to developing and implementing a rigorous monitoring program to evaluate the effectiveness of recovery actions and to providing a feedback loop for adaptive-management. These efforts, if successful and sustained, should help recover the SNS.

2.4. Five-Factor Analysis

2.4.1. Factor A - Present or threatened destruction, modification, or curtailment of its habitat or range

Habitat Loss and Alteration

Historic habitat loss

Loss and alteration of aquatic habitats (including SNS spawning and rearing habitats, and associated wetlands) was a major factor leading to the listing of the SNS (USFWS 1988). Historically, habitat loss and alteration was especially pronounced in the Lost River–Tule Lake and Lower Klamath sub-basins, where approximately 150,000 acres (approximately 77%) of sucker spawning and rearing habitat were lost in the draining of Tule Lake and Lower Klamath Lake early in the 20th century (USFWS 1988; NRC 2004). As well as containing large areas of habitat, these lakes also likely provided a repository for larval and juvenile suckers drifting out of Upper Klamath Lake during periods of high water in the upper basin. Today, most suckers drifting out of Upper Klamath Lake are effectively lost to the population (NRC 2004).

At Upper Klamath Lake, about 70 percent of the original 50,000 acres of wetlands surrounding the lake were diked and drained between 1889 and 1971, leaving about 16,000 acres of wetlands remaining connected to the lake in 1990 (Snyder and Morace 1997; Aquatic Science Resources 2005). These wetlands, especially those on the east side of the lake where most of the young fish are located, probably provided a substantial amount of rearing habitat for larval and juvenile suckers. Also, wetlands are important to the quality of sucker habitat because they likely play a key role in regulating nutrients, especially phosphorus (Graham et al. 2005), which is the primary factor encouraging algae blooms that can cause sucker die-offs (Aquatic Science Resources 2005).

Recent habitat loss

Currently, most actions that would remove wetland habitat are under jurisdiction of the U.S. Army Corps of Engineers (USACE). When such actions are likely to affect species listed under the Endangered Species Act (Act), the USACE is required to consult with the Service pursuant to section 7 of the Act. Review of recent USACE section 7 consultations indicates that some relatively minor wetland losses still occur in the upper basin, but effects of these actions on SNS are minimized during project planning and consultation.

Habitat restoration

As discussed elsewhere in this review, approximately 400 habitat restoration projects have been completed or are being planned in the Upper Klamath Lake Basin. Because the restoration efforts are recent, population level changes for SNS have not yet been detected. However, localized increases of LRS in restored areas are being realized. For example, increases of larval suckers were detected in restored areas of the Lower Williams Delta (Crandall 2004; TNC 2006, 2007). Additionally, preliminary data has detected extended rearing of larval suckers in the Sprague River that is believed to be the result of habitat restoration activities (R. Parrish pers. comm.)

In summary, extensive modification of the watersheds and wetlands of the Lost River - Tule Lake system, the Lower Klamath Lake system, and the Upper Klamath Lake system resulted in substantial loss of SNS habitat. The rate of habitat change has slowed markedly, but only a small fraction of the original habitat remains, and much of the remaining habitat is in a degraded condition (as discussed in the following sections). Restoration efforts are beginning to reverse the trend, but will probably require many years to produce a substantially increased and stable habitat base for the SNS.

Adverse Water Quality

In general, lake suckers such as SNS are relatively tolerant of water quality conditions unfavorable for many other fishes, tolerating higher pH, temperature, and un-ionized ammonia concentrations, and lower dissolved oxygen concentrations (Saiki et al. 1999; NRC 2004). Nevertheless, despite their relatively high tolerance for poor water quality, SNS are adversely affected by poor summer water quality in Upper Klamath Lake and the Lost River Basin (NRC 2004).

Most of the water bodies currently occupied by SNS do not meet various water quality standards for nutrients, DO, temperature, and pH set by the States of Oregon and California (ODEQ 2002; NCRWQCB 2006). In particular, summer water quality in Upper Klamath Lake presents challenging conditions for SNS. These conditions have caused several incidents of mass mortality of fish (i.e., “die-offs”), that have included adult suckers. Mortality appears to be primarily a result of inadequate amounts of DO, but disease is also likely involved (Foott, *in litt*. 1997; Holt 1997; Perkins et al. 2000; ISRP *in litt*. 2005). Poor water quality may also lead to mortality of young suckers and physiological impairment short of death, but the data on these effects are less clear (NRC 2004). Loss of substantial portions of young age classes could be expected to limit recruitment. Because all SNS life stages (larvae, juveniles, and adults) in the Upper Klamath Lake watershed are almost entirely confined to the lake during the summer when water quality is poor, the entire SNS population in the watershed is vulnerable to water-quality-related die-offs.

<u>Nutrient Loading</u>

Upper Klamath Lake was highly productive or “eutrophic” prior to settlement by Europeans in the mid-19th century, but it has since become even more productive or “hypereutrophic” (ODEQ 2002; Eilers et al. 2004; Bradbury et al. 2004).
Nutrient loading, from both external (pumping of diked wetlands and run-off from farms and roads along the tributaries) and internal (from lake sediments) sources, is driving the hypereutrophic conditions in Upper Klamath Lake (Snyder and Morace 1997; ODEQ

2002; IMST 2003; NRC 2004). The primary nutrient responsible for the hypereutrophic condition of the lake is phosphorus, which is borne by and stored in sediment (ODEQ 2002; Graham et al. 2005). Sediment accumulation rates dramatically increased during the 20th century, and these "modern" sediments are higher in nitrogen and phosphorus than pre-settlement sediment (Eilers et al. 2001, as cited in ODEQ 2002).

According to ODEQ, most of the pollutant load entering Upper Klamath Lake comes from non-point sources, rather than discrete point sources. The TMDL established for Upper Klamath Lake by the ODEQ is based on the premise that reduction in phosphorus-laden sediment reaching the lake is the primary means for improving water quality (ODEQ 2002). An annual average of approximately 60 percent of the phosphorus available to the water column is derived from lake sediments (ODEQ 2002). Because the source of phosphorous is the naturally occurring sediments, some authors have expressed pessimism regarding prospects for remediation (NRC 2004). However, ODEQ (2002) believes that reduction in total phosphorus loading can improve water quality to the point that standards are eventually attained.

Restoration of wetlands adjacent to Upper Klamath Lake could also play a pivotal role in improving water quality, because wetland plants and soils store substantial amounts of phosphorus (Graham et al. 2005). If phosphorus is stored in these wetlands, it is logical to assume that those nutrients would not be contributing to the hypereutrophic conditions now present in the lake. Wetlands have a high degree of naturally occurring plant and animal decomposition that creates substances that are known to inhibit growth of algae. Restoration of wetlands could help reduce blooms of *Aphanizomenon flos-aquae* (AFA), a blue-green algae that causes further water quality problems in Upper Klamath Lake (as discussed below) (Aquatic Science Resources 2005).

It is not yet definitively known whether wetland restoration and water quality improvements can lead to improved SNS populations. At the present time, sucker populations have not been demonstrably improved by the recent attempts to improve wetlands and water quality, and it may be many years before such relationships can be conclusively demonstrated. However, providing that water quality and wetland habitat in Upper Klamath Lake can be gradually improved, and SNS populations can avoid repeated large scale die-offs in the meantime, it is reasonable to assume that larger, more stable populations will result.

Aphanizomenon flos-aquae

The poor water quality in Upper Klamath Lake is especially associated with high abundance of a blue-green alga called *Aphanizomenon flos-aquae* (AFA). Core samples of bottom sediments indicate that AFA was not present in UKL prior to the 1900s (Eilers et al. 2004; Bradbury et al. 2004). Its appearance is believed to be associated with increases in productivity of the lake (NRC 2004; Aquatic Science Resources 2005).

Aphanizomenon flos-aquae now dominates the algal community from June to November, and because of the high concentrations of nutrients available, is able to reach seasonally high biomass levels that lead to highly degraded water quality (ODEQ 2002). During the large, temporary "blooms" that occur during favorable summer conditions in Upper Klamath Lake, AFA constitutes over 90 percent of the biomass of photosynthetic organisms in the lake (ODEQ 2002). These blooms are subject to massive population crashes. The rapid decay of large quantities of algae then causes extreme DO depletion in the lake, which has caused a number of documented fish die-offs (Perkins et al. 2000; ODEQ 2002; IMST 2003; NRC 2004; Wood et al. 2006). Such events not only kill thousands of suckers, but they can temporarily reduce the reproductive capacity of the populations by eliminating the larger and more fecund females. Adverse water quality is also likely to be impacting young suckers, but information is lacking regarding such effects (VanderKooi, pers. comm. 2005).

In summary, adverse water quality is the most critical threat to the SNS, and substantial improvement is not expected in the near future. Based on the record of the past two decades and the expected future summer water quality of Upper Klamath Lake, it is reasonable to conclude that within the foreseeable future, there is a high probability of multiple mortality events that would greatly reduce SNS population sizes. It is possible that infrequent recruitment would be unable to offset declines from such die-offs.

Prolonged Drought and Low Lake Levels

Drought has been identified as a potential impact to SNS in both Clear Lake and Upper Klamath Lake (ISRP *in litt.* 2005). Clear Lake is vulnerable to drought because of low precipitation in the watershed, minimal groundwater input, corresponding low net inflows, and high evaporation rates (Hicks, pers. comm. 2006). Low lake levels could adversely affect SNS by limiting access to Willow Creek, the only known spawning tributary (Buettner and Scoppettone 1991). Suckers concentrated in shallow water are also likely to experience increased incidences of disease, parasitism, and bird predation (USBR unpublished data cited in USFWS 2002). Also, during low water periods it is reasonable to assume that the resulting high densities of fish are likely to deplete the food supply, thus adding additional stress. Despite these potential adverse effects resulting from low lake levels, suckers have survived droughts historically, and thus appear to be resilient to the effects of drought.

Though affected by the same regional droughts that affect Clear Lake, Upper Klamath Lake is not as sensitive to drought, because inflows of surface and groundwater from areas of higher precipitation in the Cascade Range are much higher and less variable (USBR 2005b). However, Upper Klamath Lake levels are affected by drought to some degree, because it is shallow (average depth in summer = 7.1 ft), and because during droughts, larger irrigation diversions are needed to offset low soil moisture in agricultural fields and on wildlife refuges (Hicks, pers. comm. 2006). If severe drought were to result in substantial and prolonged lowering of tributary inflows and lake levels, it is likely that habitat availability would be adversely affected for all SNS life stages, including spawning, larval and juvenile rearing, and adult use of water quality refuge areas (Cooperman and Markle 2004; Helser et al. 2004; Loftus and Reiser 2004).

In summary, drought is a threat to the SNS because of its potential to cut off spawning habitat, to reduce rearing habitat and to increase disease, parasitism, and predation. However, historically SNS has endured periods of prolonged drought and persisted, indicating that drought is not a major threat to the species.

Entrainment and Inadequate Fish Passage

Unscreened diversions were identified as a threat to the suckers at the time of listing (USFWS 1988). Since then, private landowners, the Oregon Department of Fish and Wildlife, USBR, the NRCS, the Service, and others have built or funded construction of many new fish screens in the upper basin. As a result, the threat of entrainment (loss of fish as result of being drawn into water management structures) is now lower than at the time of listing. Recently-installed fish screens in the upper basin include A-Canal (in 2003); Agency Lake Ranch (in 2002); Clear Lake (in 2003); Miller Island (in 2003); and Wood River Ranch (in 2004). Below, we discuss specifically the A-Canal, Link River Dam and Chiloquin Dam, places where entrainment has occurred in the past or is currently occurring, and where screening and passage programs are being implemented or planned.

<u>Entrainment at the A-Canal and Link River Dam</u>

The A-Canal irrigation diversion, the Link River Dam, and the associated Link River hydroelectric facilities are located near the outlet of Upper Klamath Lake, at the head of Link River. Prior to screening by Reclamation in 2003, thousands of suckers, including some adults, were lost into the A-Canal, the largest diversion in the upper basin. Although some of these fish were salvaged, many likely died, and the NRC (2004) noted the importance of screening this diversion. The A-Canal screen now excludes all suckers >30mm in length, is preventing many sucker larvae from being entrained into the canal, and is not harming fish (Korson, pers. comm. 2007; North State Resources, Inc. 2005). Currently, we cannot quantify the degree of population improvement provided by this screen, but based on a recent Reclamation pilot telemetry study involving a few fish, some suckers prevented from entering the A-Canal have successfully returned to the Upper Klamath Lake population. Thus, the A-Canal screen is having some degree of positive effect. However, other fish in the pilot study were subsequently drawn through the nearby Link River Dam gates or into the PacifiCorp hydroelectric canals at the ends of Link River Dam (Korson, pers. comm. 2007).

Prior to construction of the A-Canal screen, Gutermuth et al. (2000) found that tens of thousands of young suckers were entrained at the PacifiCorp hydropower canals, and similar entrainment has also been observed recently (Markle, pers. comm. 2007). Fish drawn into the power canals may pass through the turbines and on into the Link River, with unknown amounts of mortality. Since suckers are no longer entering the A-Canal, it is possible that even more are now entering the hydroelectric canals than before the A-Canal was screened, but no recent quantitative studies have been conducted.

The entrainment of suckers at the Link River hydroelectric facilities may be addressed during the relicensing of the Klamath Hydroelectric Project. In their 2004 relicensing application, PacifiCorp sought approval to abandon the hydropower facilities at Link River Dam (PacifiCorp 2004), but it is presently unclear whether that will occur. Prescriptions filed by the Service (U.S. Department of Interior 2007), if eventually included by the Federal Energy Regulatory Commission in the license, would require PacifiCorp to screen these diversions.

Substantial entrainment is also occurring at the river gates of the Link River Dam, which regulate water flowing downstream into Lake Euwana, Keno Reservoir, and the Klamath River. Currently these gates have no protection against fish being drawn downstream. During the late summer of 2006, over 6,000 age-0 juvenile suckers were collected in the Link River just below the dam during intermittent sampling of a small fraction of the channel (Korson pers. comm. 2007). The NRC (2004) recommended screening to prevent downstream losses at Link River Dam. Reclamation is evaluating potential modification of the Link River Dam gates to reduce entrainment of young suckers, but pilot efforts have encountered unanticipated complications, and presently the effort is not expected to continue in 2007 (Korson, pers. comm. 2007).

Most suckers that pass through the gates at Link River Dam, or that survive passage through the hydroelectric facilities, are believed to be lost from the breeding population. Most likely, these fish either die in poor summer water quality conditions in Lake Euwana or Keno Reservoir, or are passed on downstream into the Klamath River reservoirs, from which they cannot return. Some adult suckers now return upstream from Link River through the new ladder at Link River Dam, but this return has not been quantified (Korson, pers. comm. 2007).

The impact of these entrainment losses to the Upper Klamath Lake breeding population is unknown. There probably always has been some loss of suckers down Link River from the Upper Klamath Lake population. In the early 20th century, prior to the construction of the railroad across Lower Klamath Lake and the subsequent draining of that lake, some suckers from Link River may have entered Lower Klamath Lake, but that possibility no longer exists.

Chiloquin Dam

Chiloquin Dam is located on the Sprague River near the town of Chiloquin. It was identified in the 1988 listing as a threat to the listed suckers because it was thought to block access to upstream spawning areas (USFWS 1988). The dam is equipped with fish ladders, but these were not designed for suckers, and therefore we concluded that suckers were blocked from migrating upstream. Based on the total number river miles upstream of the dam, versus those downstream, we concluded that the dam could block 95% of the spawning habitat (USFWS 1988). However, that conclusion was based on three assumptions: (1) all upstream habitat was suitable for spawning; (2) if the dam were removed, suckers would use all of the upstream habitat; and (3) the dam blocked all upstream migrations.

The NRC considered Chiloquin Dam in their evaluation of factors that have contributed to the decline of SNS (NRC 2004). They found that the loss of access to upstream spawning habitat resulting from the construction of Chiloquin Dam is a factor in SNS declines, and recommended the removal of Chiloquin Dam as a high priority (NRC 2004).

More recently, studies by USGS have found that some suckers are able to pass over Chiloquin Dam. Sampling has not been sufficient to determine what portion of the population is able to pass through the ladder, but especially in low flow years, most of the population appears to spawn in the Sprague and Williamson Rivers below the dam (Shively pers. comm. 2007). If able to pass through the ladder, some suckers move many miles upstream of the dam to spawn. Lost River suckers fitted with small radio transmitters have been detected over 100 km (about 60 miles) upstream of the dam (Ellsworth et al. 2007). However, the restricted passage over the dam results in a high concentration of suckers spawning just below the dam, with increased predation and possible harm to eggs and larvae as crowded fish attempt to spawn in a limited area (Ellsworth et al. 2007). Based on current information, we now regard the dam as a substantial impediment to sucker passage, rather than a complete barrier.

Chiloquin Dam was initially planned for removal in 2007 (BIA 2005), but due to unforeseen circumstances, removal has been delayed until 2008 (Korson, pers. comm. 2006). In their environmental assessment for the dam removal project, the Bureau of Indian Affairs (BIA) determined that "…improved passage would benefit both species of endangered suckers and aid in their recovery, but the extent of benefits would likely depend on the quality and quantity of upstream spawning habitat" (BIA 2005). It is premature to draw conclusions about population level benefits at this time.

Screening and passage programs

Various State and Federal screening and passage programs, now coordinated in the upper basin through a working group led by USBR, are addressing the need for additional screening and passage for suckers (ISRP, *in litt*. 2005). The number of unscreened diversions in sucker habitat is unknown, but we believe they number several hundred. For several reasons, we do not believe that most of these small diversions pose a serious threat to listed sucker populations. During the season when these diversions are in use, most suckers are in Upper Klamath Lake. Also, the diversions are small with relatively moderate currents, so suckers entrained there are most likely to be larvae, which are produced in large numbers and suffer very high rates of natural mortality.

In summary, fish entrainment and restricted passage are threats to SNS. Entrainment at Link River Dam and associated hydropower diversions likely poses a high risk to the SNS. The threat there could be reduced if the hydropower diversions are screened or eliminated, and if discharges at the dam could be modified to reduce entrainment. Passage to spawning habitat in the Sprague River is still impeded by Chiloquin Dam, but that structure is planned for removal in the near future. Elsewhere in the upper basin, some entrainment of suckers is occurring, but mostly larvae are entrained, and we do not consider this a substantial threat at the population level.

Summary of Factor A

Of all of the five factors, we believe that the threats discussed under factor A pose the greatest risk to the SNS. Adverse water quality is the most critical threat to the SNS, and substantial improvement is not expected in the near future. Based on the record of the past two decades and the expected future summer water quality of Upper Klamath Lake, it is reasonable to conclude that within the foreseeable future, there is a high probability of multiple mortality events that would greatly reduce SNS population sizes. Entrainment at Link River Dam and associated hydropower diversions likely poses a risk to the SNS. Passage to spawning habitat in the Sprague River is still impeded by Chiloquin Dam, but that structure is planned for removal in the near future. The rate of habitat loss has slowed from historic levels. Restoration efforts are beginning to reverse the trend, but will probably require many years to produce a substantially increased and stable habitat base for the SNS.

2.4.2. Factor B - Overutilization for commercial, recreational, scientific, or educational purposes

We do not consider overutilization for commercial, recreational, scientific, or educational purposes a threat to the SNS. The State of California designated SNS as fully protected on January 1, 1974, resulting in the prohibition of the take or possession of the fish. The sport fishery for suckers in Oregon was closed prior to Federal listing in 1988 and has not reopened. The Klamath Tribes, who historically relied on the SNS or "quapdo" for food, no longer harvest the species. Now, the only utilization of suckers is for scientific purposes, and the Service and State of Oregon closely monitor take through a carefully-managed permit process to ensure that it does not become a threat.

2.4.3. Factor C - Disease or predation

Disease

Disease was not identified as an important threat at the time of listing. However, new information indicates that pathogens substantially affect sucker survival, especially during the adverse water quality events described above. Although fish die-offs that occurred in Upper Klamath Lake in the 1990s were likely a response to hypoxia (low levels of DO), disease outbreaks also probably contributed to mortality during these events (Perkins et al. 2000; NRC 2004).

A number of pathogens have been identified from moribund (dying) suckers, but Columnaris disease or "gill rot" seems to be the primary organism involved (Foott 1997; Holt 1997). Columnaris disease is caused by the bacterium *Flavobacterium columnare*, which can cause massive damage to the gills and produces lesions elsewhere on the body.

This leads to respiratory problems, an imbalance of internal salt concentrations, and provides an entry route for systemic pathogens that can cause death (ISRP *in litt*. 2005).

Parasites

Parasites were not identified as a threat at the time of listing, but recent information indicates they could be a threat to the suckers. In 1971, a large fish die-off occurred in Upper Klamath Lake, affecting an estimated 30 million fish, mostly chubs. The numbers of suckers involved in the 1971 event are unknown. One of the potential causative factors identified in this die-off was *Lernea* sp., a parasitic copepod or "anchor worm," which feeds on fish tissues by puncturing the skin of their host (Briggs 1971).

Lernea parasitism rates on age 0 suckers appear to be increasing in Upper Klamath Lake (Carlson et al. 2002; ISRP *in litt*. 2005). From 1994-1996, the percent of age 0 suckers parasitized by *Lernea* sp. ranged from 0-7%, but by 1997-2000 it had increased to 9-40%. *Lernea* now infects about half of age 0 SNS (Markle, pers. comm. 2005).

The degree to which parasites affect sucker survival and productivity is unknown. Parasites can lead to direct mortality, provide a route for pathogens to enter fish, since they create a wound, and can make fish more susceptible to predation (Robinson et al. 1998). Low survivorship of endangered razorback suckers in a reintroduction program in the Verde River in Arizona has been partially attributed to infestations of *Lernea* (Robinson et al. 1998).

Predation/Competition by Exotic Fishes

Exotic fishes were identified as a potential threat at the time of listing. Approximately 20 exotic fish species have been accidentally or deliberately introduced into the upper basin (Logan and Markle 1993), and they made up about 85% of the fish biomass in Upper Klamath Lake at about the time the suckers were listed (Scoppettone and Vinyard 1991; NRC 2004).

Exotic fish species most likely to affect SNS are the fathead minnow (*Pimephales promelas*) and yellow perch (*Perca flavescens*). These exotic fish are suspected to prey on young suckers and compete with them for food or space (Dunsmoor and Markle, in preparation; Buettner, pers. comm. 2006). Additional exotic, predatory fishes found in sucker habitats include bullheads (*Ictalurus* spp.), largemouth bass (*Micropterus salmoides*), crappie (*Pomoxis* spp.), green sunfish (*Lepomis cyanellus*), and Sacramento perch (*Archoplites interruptus*) (Koch et al. 1975; Logan and Markle 1993). Their effect on suckers is unknown, and we suggest that it would depend on other factors such as their abundance in sucker habitat and availability of other prey.

Fathead minnows were first documented in the Klamath Basin in the 1970s and are now the numerically dominant fish in Upper Klamath Lake (Andreasen 1975; Simon and Markle 1997). Laboratory studies have demonstrated that adult fathead minnows feed on sucker larvae, and that predation rates decrease with increased vegetative cover and water depth (Markle and Dunsmoor 2007). Field studies in Upper Klamath Lake by the same authors found negative relationships between fathead population size and larval sucker survival rates; and that higher larval survival rates were also associated with greater water depth and shoreline vegetative cover, factors which help larvae avoid predation (Markle and Dunsmoor 2007). These studies indicate that predation by the abundant introduced fathead minnows is an important factor in larval sucker mortality rates, and that loss of emergent wetland habitat may have exacerbated this predation.

Summary of Factor C

In summary, disease, parasites, and predation/competition by exotic fishes pose some risk to the SNS, although the degree to which they affect the SNS is not quantified. Disease and parasites alone may not pose a significant risk, but paired with the impacts of adverse water quality, they can substantially affect sucker survival.

2.4.4. Factor D - Inadequacy of existing regulatory mechanisms

Federal and State regulations directly or indirectly affect SNS populations. The primary areas of regulatory authority affecting the SNS are the Act, the California Fish and Game Code, the Oregon Endangered Species Act, water quality regulations, and water quantity regulations.

U.S. Endangered Species Act

The Act has provided the primary regulatory protection mechanism for the SNS since its listing in 1988. The primary sections of the Act affecting the status of the species are sections 7, 9, and 10, as discussed below. The NRC (2004) recommended greater application of sections 7 and 9 of the Act by the Service for protection of suckers. The NRC panel believed there was "…ample basis for each agency [i.e, regarding suckers, the FWS] to extend its authority to prohibit take…" (NRC 2004).

Section 7 of the Act requires Federal agencies to consult with the Services (USFWS and NOAA) if their actions may affect listed species, and provides the mechanism for authorization of incidental take where such take will not jeopardize the species. We regularly consult with many Federal agencies in the upper basin, including the Forest Service, Bureau of Land Management, Federal Highway Administration, Corps of Engineers, NRCS, and USBR. We also consult on all of our own projects that may affect listed species. In these consultations, authorization of take is subject to implementation of measures to reduce impacts to the species, and thus application of section 7 generally appears to be an effective regulatory tool for conservation of SNS.

Section 9 of the Act prohibits "take," which includes killing or injuring listed species, either directly or through impacts to their habitat. The Service has not carried out law enforcement actions regarding suckers under the take prohibitions of ESA section 9.

Along with other agencies, the Klamath Tribes, and many private citizens, we have been making steady progress on reducing causes of sucker mortality related to practices on non-Federal lands and projects. We believe that this is the most effective way to accomplish protection of suckers in the long term, and therefore we have exercised our continuing discretion to defer law enforcement actions. Such actions remain as an option should they be necessary.

Section 10 of the Act authorizes scientific permits for research or to enhance the survival and recovery of listed species; incidental take permits for non-federal parties based on a habitat conservation plan that will not appreciably reduce the likelihood of survival and recovery of the listed species; and experimental populations outside a species' current range. The Service provides research permits under conditions that are protective of sucker populations. We have no reason to believe that these activities are detrimental to sucker populations. As of the date of this review, no non-federal parties have sought incidental take permits for suckers under ESA section 10, other than for scientific research. If important causes of take are identified that are appropriate for application of the incidental take authorizations for non-Federal parties under section 10, we will encourage the involved parties to enter into negotiations under that section.

Probably the most important indirect effect of ongoing regulation under the Act is the growing effort in various portions of the community to improve conditions for suckers through restoration actions. The degree to which these actions are improving the status of suckers is unquantifiable, but it is reasonable to conclude that improvements in habitat should have positive effects on the species.

In conclusion, application of existing Act authorities, especially section 7, is probably maintaining existing sucker habitats, and leading to reductions in mortality and improvements in habitat. However, given the continued vulnerability of the species to existing seasonal habitat conditions described elsewhere in this review, these regulations have not been sufficient to substantially reduce the primary threat to the species.

California Endangered Species Act

The SNS was listed as endangered under the California Endangered Species Act in 1974 (California Code of Regulations Title 14, Section 670.5; CDFG 2006). It is also listed as a fully protected species under California Fish and Game Code section 5515(a)(3)(b)(4). Fully protected species may not be taken or possessed at any time, except for scientific research or recovery efforts.

Oregon Endangered Species Act

The SNS is listed as endangered under the Oregon Endangered Species Act of 1987 (Oregon ESA), as amended. The Oregon ESA prohibits the take (to kill, take possession of, or control) of SNS (Oregon Administrative Rules 635-100-001 through 0180). However, the Oregon ESA only affects actions of State agencies on State-owned or leased lands. It requires State agencies to consult with Oregon Department of Fish and

Wildlife (ODFW) if their actions on State land would violate the survival guidelines developed for a listed species. ODFW can recommend reasonable and prudent alternatives that are consistent with the survival guidelines.

Water Quality Regulations

The Clean Water Act (33 U.S.C. 1251) regulates the discharge of pollutants into waters of the United States and sets water quality standards for all contaminants in surface waters. Section 303(d) of the Clean Water Act requires that states identify waterbodies that do not meet those standards and develop water quality management plans to achieve standards and protect beneficial uses. The Oregon Department of Environmental Quality (DEQ) has identified a number of waterbodies in the Klamath Basin as impaired, including Upper Klamath Lake and its tributaries (http://www.deq.state.or.us/wq/303dlist/303dpage.htm). The California North Coast Regional Water Quality Control Board has identified the Lost River, Clear Lake and a number of water bodies in the Lower Klamath River Sub-basin as impaired (http://www.waterboards.ca.gov/tmdl/docs/2002reg1303dlist.pdf).

In 2002, the Oregon DEQ adopted a TMDL and Water Quality Management Plan (WQMP) for the Upper Klamath Lake watershed. It is hoped that the TMDL and WQMP will improve water quality through the reduction of phosphorus inputs from non-point sources such as erosion of roads and stream banks. The amount of external phosphorus loading to the lake from nearby drained wetlands has declined substantially during the period of recent wetland restoration efforts (ODEQ 2002). However, ODEQ (2002) did not indicate that similar patterns have been observed for other sources of external loading, such as erosion to tributary streams.

It remains uncertain whether a reduction in external phosphorus loading will have a substantial beneficial affect on the lake, because levels of phosphorus in the existing lake sediments could be sufficient to promote continued AFA blooms (NRC 2004). Some limnologists who have studied the system believe that reducing external nutrient loading can, over a number of decades, improve Upper Klamath Lake water quality to a point where the frequency/intensity of fish die-offs is lower (ISRP, *in litt*. 2005). Nevertheless, it appears that episodes of hazardous water quality will remain as an important threat to suckers in Upper Klamath Lake for many years to come (NRC 2004.).

TMDL processes are also underway in the Lost River and Klamath River sub-basins, with both scheduled to be completed in 2007. These processes could have beneficial effects to suckers in the future (http://www.waterboards.ca.gov/northcoast/programs/tmdl/klamath/klamath.html).

In conclusion, although it is reasonable to expect future improvements under existing water quality regulations and restoration programs, application of existing regulations has not yet resulted in substantial reduction of threats to suckers.

Water Quantity Regulations

The Upper Klamath River watershed lies in the Cascade Mountains rain shadow. This results in a relatively low mean annual precipitation (27 inches), most of which falls in the form of snow (NRC 2004). The quantity of water available in sucker habitat is dependent on this climatic pattern and its affect upon stream-flow and groundwater inputs. These inputs are influenced by human uses of water, some of which are subject to regulation. With the exception of direct prescription of lake levels through ESA section 7, regulation of water quantity is not directly focused on maintenance of sucker habitat.

Inadequate water quantity in sucker habitats was not listed as a factor affecting suckers at the time of listing. The recovery objectives in the Recovery Plan identified the need to secure long-term water rights to ensure that water quantities in sucker habitat would support stable populations (USFWS 1993). However, no water rights have been obtained specifically for benefit of suckers.

Quantities of water necessary for conservation of suckers in Upper Klamath Lake and Clear Lake are not precisely known. The NRC (2004) found no statistical relationship between Upper Klamath Lake levels and sucker survival during the 15-year period for which data were available and recommended that the lake be managed to meet the average level of the past ten years. Under ESA section 7 consultations, Upper Klamath Lake has been managed to meet that goal since 2002 (USFWS 2002; USBR 2004, 2005a, 2006).

Lake levels ultimately affect the amount of lake-shore habitat for spawning and larval and juvenile rearing. Also, at higher lake levels, areas of the lake may exist where fish can find refuge from poor water quality. Therefore, at some point reduction of lake levels would be reasonably expected to have adverse effects (ISRP, *in litt*. 2005). However, it is currently unclear to what degree management of water storage in the lake affects use of these habitats by suckers, and to what degree changes in management might increase sucker productivity and survival.

To the extent that groundwater inputs influence sucker habitats, regulation of groundwater withdrawal might affect suckers, but specifics of these relationships are not known. Continued development of groundwater is occurring in both the Oregon and California portions of the upper Klamath Basin. The State of Oregon, through the Groundwater Act of 1955, regulates groundwater use through groundwater removal permits (Oregon Revised Statutes Sections 537.505 to 537.795 and 537.992). Most California groundwater is unregulated, and the State has no comprehensive groundwater permit process to regulate ground water withdrawal (California State Water Code Section 1200).

Aside from the application of section 7 of the ESA discussed above, regulation of the quantity of water available in sucker habitats primarily involves the exercise of surface water rights for agriculture in both Oregon and California. Water rights claims by agriculture and other users in the Upper Klamath Lake sub-basin have been under adjudication by the Oregon Department of Water Resources since 1975. Current claims likely exceed available supplies because claims are numerous and substantial, and available supplies are sometimes limited (Bastach 1998). Completion of adjudication of water rights in Oregon could affect the amount of water available in Upper Klamath Lake during droughts, because senior rights held by the Bureau of Reclamation and Klamath Tribes would have priority over upstream uses under junior rights.

In conclusion, the only direct regulation of water quantity on behalf of suckers occurs subject to ESA section 7 consultation, and the benefits of that management cannot currently be quantified. Other regulation of water quantity may affect sucker habitats, but these relationships are not well understood, so specific conclusions cannot be drawn regarding the adequacy of such regulations.

Summary of Factor D

Since the listing, protections under the Act have limited take of suckers and stimulated restoration actions. Water quality regulations have begun to lead toward improved water quality, but have not yet resulted in substantial improvement, and significant questions remain regarding the potential for improvement in Upper Klamath Lake. With the exception of management of water quantity under the Act, regulation of water quantity is not focused on improvement of sucker habitat, and relationships between water quantity and sucker performance remain incompletely demonstrated. Thus, while application of federal and state regulations has apparently helped stabilize sucker habitat and has initiated progress toward improvement of water quality, existing regulations cannot be expected to substantially reduce the primary threat to the species for many years.

2.4.5. Factor E - Other natural or manmade factors affecting its continued existence

Hybridization

Hybridization was identified at the time of listing as a threat to the SNS. New data suggest that hybridization among four Klamath Basin suckers (SNS, Lost River sucker (*Deltistes luxatus*), Klamath largescale sucker (*Catostomus snyderi*) and Klamath smallscale sucker (*Catostomus rimiculus*) probably does occur (Dowling 2005; Markle et al. 2005; Tranah and May 2006). Recent genetics studies appear to indicate that the Clear Lake and Gerber Lake populations may have experienced extensive hybridization (ISRP *in litt*. 2005). Hybridization can be cause for concern for an imperiled species, even leading to extinction (Rhymer and Simberloff 1996). However, at this time, scientists who have studied Klamath suckers do not consider hybridization among them to be unusual (Dowling 2005; Tranah and May 2006). The evidence indicates that hybridization has been common throughout the evolutionary history of suckers, in general, and Klamath Basin suckers, in particular (Dowling 2005; ISRP, *in litt*. 2005). The specific impact, if any, of this hybridization upon the speces conservation status is unclear and warrents further analysis.

2.5. Synthesis

Historically, SNS were found throughout the Klamath Basin at numbers large enough to support robust tribal fisheries. At the time of listing, SNS populations were believed to have declined substantially and were found primarily in Upper Klamath Lake and Lost River basins. Although new information suggests that the numeric population estimates at the time of listing may have been inaccurate, it is known that the population was experiencing a sharp downward trend and lacked recruitment. Current SNS population numbers are unknown, but recent data indicate that the population has not recovered from the substantial declines in the 1990s.

Adverse water quality is the greatest remaining threat to the Upper Klamath Lake SNS. Based on the record of the past two decades, it is reasonable to expect additional water quality related die-offs. Based on current population structure, little recruitment is expected in the near future. Without compensation from recruitment, additional die-offs would be reflected in lower population levels for years to come, increasing the risk of extirpation in Upper Klamath Lake.

The listing rule suggested that hybridization may pose a threat to SNS. Recent genetics studies appear to indicate that the Clear Lake and Gerber Lake populations may have experienced extensive hybridization. It is currently unknown what, if any, impact this hybridization may be having on these populations and further research needs to be done.

Habitat restoration work in the Klamath Basin appears to be benefiting SNS. Fish passage improvements and wetland restoration have recently occurred and are reducing some of the habitat threats for this species. Additional passage improvement and wetland restoration are planned. These restoration efforts have not yet resulted in significant changes in population numbers, but it is hoped that as work continues, population increases will be seen.

We believe that SNS continues to be threatened with extinction because of the low population levels that are experiencing a continuing downward trend, and the threat of water quality related die-offs. These threats may be further compounded by impacts from hybridization in the Clear Lake and Gerber Lake populations. Therefore, we recommend that SNS remain listed as endangered.

3.0 RESULTS

3.1. Recommended Classification

___ Downlist to Threatened

___ Uplist to Endangered

___ Delist (indicate reason for delisting per 50 CFR 424.11)

___ Extinction

___ Recovery

___ Original data for classification in error

_X_ No change is needed

3.2. New Recovery Priority Number

The SNS recovery number would be revised to "4c." This number indicates a species that has a high degree of threats and a low recovery potential. The "c" indicates that the species is in conflict with construction or other development projects or other forms of economic activity.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Improving Recruitment

SNS populations in Upper Klamath Lake declined substantially in the 1990s owing to repeated die-offs. Recruitment of young fish to the breeding population has been poor. Because the population size is relatively low, the population is vulnerable to additional water quality-related die-offs. Therefore, addressing this issue needs to have a high priority. Continuing efforts to improve water quality may not yield results for several decades. The Service should investigate options for improving recruitment.

Recovery Planning

The 1994 recovery plan for the Lost River sucker and Shortnose sucker is outdated; therefore development of a new plan should be a high priority.

Resolving the Status of SNS in the Lost River Sub-basin

Available data, both morphological and molecular genetics, indicates that SNS in the Lost River sub-basin have hybridized and introgressed with KLS. Since the listing status of the SNS in the Lost River sub-basin could be affected by hybridization, it is crucial to assess and resolve this issue.

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Personal Communications

Buettner, M.	U.S. Fish and Wildlife Service, Klamath Falls, OR
Hicks, J.	U.S. Bureau of Reclamation, Klamath Falls, OR
Korson, C.	U.S. Bureau of Reclamation, Klamath Falls, OR
Markle, D.	Oregon State University, Corvallis, OR
Parrish, R.	U.S. Fish and Wildlife Service, Klamath Falls, OR
Peterson, S.	Klamath Basin Rangeland Trust, Klamath Falls, OR.
Piaskowski, R.	U.S. Bureau of Reclamation, Klamath Falls, OR
Regan-Vienops, J.	Natural Resources Conservation Service, Klamath Falls, OR.
Ross, D.	U.S. Fish and Wildlife Service, Klamath Falls, OR.
Simon, D.	Oregon State University, Corvallis, OR
Shively, R.	U.S. Geological Survey, Klamath Falls, OR
Tyler T.	U.S. Geological Survey, Klamath Falls, OR
VanderKooi, S.	U.S. Geological Survey, Klamath Falls, OR.

U.S. FISH AND WILDLIFE SERVICE

5-YEAR REVIEW of Shortnose sucker (*Chasmistes brevirostris*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

___ Downlist to Threatened

___ Uplist to Endangered

___ Delist

_X_ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By: Ron Larson, Klamath Falls FWO
Phil Detrich, Yreka FWO
Mary Grim, California Nevada Operations

REGIONAL OFFICE APPROVAL:
Regional Director, Fish and Wildlife Service

Approve Steve Thompson Date 7/19/2007