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WHITE PAPER
CONTRIBUTION OF THE LOST RIVER TO THE RECOVERY OF FEDERALLY LISTED LOST RIVER AND SHORTNOSE SUCKERS

Mark Buettner
US Fish and Wildlife Service
Klamath Falls, OR
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Summary

The purpose of this White Paper is to develop background and discuss the potential contribution to recovery of federally listed Lost River and shortnose suckers in the Lost River and importance of fish passage activities including upstream and downstream fishways and screens.

Lost River and shortnose suckers were historically widespread and abundant. They were relied upon as a food source by the Klamath and Modoc Indians and were taken by local settlers for both human consumption and livestock feed. In 1988, both species were listed as endangered under the federal Endangered Species Act. Reasons for their decline included: the damming of rivers, dredging and draining of marshes and shallow lakes, water diversions, hybridization, competition and predation by non-native fish, insularization of habitat, and water quality problems associated with timber harvest, removal of riparian vegetation, livestock grazing, and agricultural practices.

Tule Lake, the Lost River, and Clear Lake provide habitat for the federally listed Lost River and shortnose suckers, and have done so historically. However, Tule Lake was reduced in size to about 10-20% of its historic size and the water depth was greatly reduced. In addition, 8 diversion dams were constructed that block upstream passage of suckers from Tule Lake to historic spawning and rearing areas. The Lost River was channelized and flow regimes substantially altered. The Lost River is currently managed as a water conveyance system. Spawning habitat is very limited. Tule Lake is very shallow (< 4 feet) and may soon become too shallow for suckers because of sedimentation. With the exception of Clear Lake and Gerber Reservoir, Lost River and shortnose sucker populations in Tule Lake and the Lost River are small. Lost River suckers are extremely rare in the Lost River. Extensive hybridization has taken place among shortnose suckers in the Lost River system. The value of upstream and downstream passage in the Lost River would be questionable. Providing connectivity between the Lost River and Klamath River is also questionable due to the poor habitat conditions in the Lost River and the genetic status of the shortnose suckers in the Lost River. However, since Lost River and Tule Lake support small self-sustaining populations of suckers they are valuable for the long-term survival of both species of suckers, especially given the continuation of fish kills in Upper Klamath Lake. However, due to the lack of lacustrine habitat, there is not much opportunity to increase populations

in the Lost River system. Gerber and Clear Lake provide the best habitat for suckers and should be given the highest priority. Due to major population limiting factors including the lack of spawning and rearing habitat in the Lost River, passage at the larger dams including Anderson Rose, Wilson, Malone, and Clear Lake is not justified. Screening of diversions in the Lost River also does not appear justified at the present time. Based on sucker status surveys, shortnose sucker populations have been sustained even with the development and operation of the Klamath Project over the last century on the Lost River. Specific to the Lost River Diversion Canal, reducing entrainment from the Lost River is not likely a significant threat to the population. However, reducing entrainment from the Klamath River to the Lost River may be justified.

Biology, Distribution and Status of Federally Listed Suckers

The biology of the endangered shortnose and Lost River suckers is generally well known (USFWS 2001). Lost River suckers in the Lost River system occupy primarily lacustrine habitat in Tule Lake and Clear Lake and spawn in lower Lost River (Tule Lake fish) and in Willow and Boles Creeks (Clear Lake fish). Shortnose sucker populations are more widespread, occupying Clear Lake and its tributaries, Gerber Reservoir and its tributaries, Lost River, and Tule Lake.

Clear Lake

Because there is no fish passage over Clear Lake Dam, it is apparent that suckers were present in the lake prior to the completion of the dam in 1910. The earliest studies on suckers in Clear Lake were done in the early 1970s (Koch and Contreras 1973, Sonnevil 1972, Andreasen 1975). Collections made of Lost River and shortnose suckers in Clear Lake between 1989 and 1993 showed a wide range of size classes, indicating fairly consistent recruitment (Buettner and Scoppettone 1991, Scoppettone et al. 1995, Reclamation 1994). Additional population monitoring conducted in 2000 and 2004 also indicated a diverse age class structure and relatively large population numbers (USGS, unpublished data). Habitat condition in the watershed above Clear Lake is relatively good. Most of the land in the watershed is managed by the US Forest Service and has been subject to ESA section 7 consultation.

Gerber Reservoir

Gerber Reservoir was built by damming Miller Creek in 1925 to provide flood protection and irrigation deliveries to Langell Valley. Reclamation monitored fish populations in Gerber Reservoir from 1992 to 1996, and USGS in 2000 and 2004 (Piaskowski and Buettner 2004, USGS unpublished data). Monitoring since 1992 at Gerber has documented a substantial shortnose sucker population exhibiting a wide range of age classes. BLM has monitored sucker spawning in tributaries to Gerber Reservoir since 1993 and documented successful reproduction in all but the driest years when fish were unable to access tributaries to spawn (BLM unpublished data).

Miller Creek

Miller Creek appears to support a small population of shortnose suckers and also provides spawning habitat for suckers that live in the Lost River (Reclamation

unpublished data). Some suckers are entrained each year from Gerber Reservoir (Reclamation salvage reports 1992, 1993, and 1997). In 2003 and 2004, Reclamation and BLM monitored entrainment at Gerber Dam and Miller Creek Diversion. A few juvenile suckers were collected at both locations. Suckers from the Lost River spawn in the lower section of Miller Creek during good water years.

Lost River - Clear Lake to Malone Dam

Reclamation has collected Lost River and shortnose suckers each year during salvage operations immediately below Clear Lake Dam, 1992-2004 (Reclamation salvage reports). However, in 2003 a fish screen was installed at the outlet gates eliminating entrainment of juvenile and adult suckers. Few suckers are believed to occupy the 8-mile reach between Clear Lake Dam and Malone Dam owing to the high gradient and lack of deep pool habitat. Additionally flows in this reach are highly variable, being high in summer during irrigation releases and low the remainder of the year when halted at the end of irrigation season.

Malone Reservoir is not believed to support a viable sucker population, but instead probably contains waifs entrained into the Lost River from Clear Lake (Buettner and Scoppettone 1991). In 1992, Reclamation transplanted 350 SNS and 4 LRS that were salvaged from Clear Lake. Malone Reservoir has not been sampled since 1992. Few suckers are suspected to reside in Malone because the reservoir is nearly drained each fall after irrigation season. Also, flows are highly variable due to seasonal releases from Clear Lake Dam for irrigation. Malone has the potential to support a self-sustaining population of suckers if a minimum reservoir pool is maintained.

Lost River – Malone to Bonanza

The 6-mile reach from Malone Dam to below Miller Creek is channelized. During the irrigation season flows are small consisting primarily of agricultural return flows. Due to the lack of habitat in this reach few suckers are expected. In 1992, Reclamation sampled a few stations with trap nets but did not catch any suckers (Reclamation unpublished data). Habitat conditions improve from Keller Bridge to Bonanza particularly with the added flow from Miller Creek. In 1992, Reclamation captured several adults during April in deeper pools (Reclamation unpublished data). In 1999, USGS collected several hundred juvenile and a few dozen adult suckers in this reach (USGS 2000).

Lost River – Bonanza to Harpold

This reach of the Lost River has the best habitat and the largest concentration of shortnose suckers owing to the significant input of Big Springs near Bonanza and Buck Creek and lacustrine habitat provided seasonally by Harpold Dam (Koch and Contreras 1973, USFWS 2001, USGS 2000). In 1992, Reclamation and Oregon Department of Fish and Wildlife biologists observed approximately 100 shortnose suckers spawning at Big Springs. USGS captured 66 adult suckers in the reach in 1999. In 2003, a fish die-off occurred in this section of river with approximately 100 adult suckers.

Lost River – Harpold to Olene

attention (FWS 2001) because they support relative large sucker populations with diverse age classes and have good habitat conditions.

While the Draft Critical Habitat designation (FWS 1994) for suckers included Clear Lake and its tributaries, Gerber Reservoir and its tributaries, Tule Lake and Lost River below Anderson Rose Dam it did not include most of the Lost River. Criteria used to identify CH included: current and historic range, suitable spawning and migration habitats, areas likely to provide water quality, areas to maintain range-wide distribution, areas to reduce fragmentation of populations and adequacy of existing protection. In that analysis it was determined that the Lost River did not meet the criteria.

Potential Contribution of Lost River to Recovery and Justification of Upstream and Downstream Passage and Screens

Aquatic habitats throughout the upper Klamath Basin are highly modified, but the Lost River has perhaps the most severely effected. The Lost River was once the primary spawning habitat for suckers in Tule Lake. However, today the Lost River supports few suckers, and furthermore, can perhaps be best characterized as an irrigation water conveyance, rather than a river. For nearly its entire 75-mile length, from Clear Lake Reservoir to Tule Lake Sump, the Lost River is highly modified to meet agricultural demands. Flows are highly regulated, it has been channelized in several reaches, its riparian habitats and adjacent wetlands are highly modified, and it receives significant discharges from agricultural drains. This has likely affected wetlands and wet meadows and may have resulted in lowered water tables, further increasing the need for irrigation.

Historically, most adult Lost River and shortnose suckers resided in Tule Lake and migrated up the Lost River to spawn near Olene or Big Springs. Spawning habitat in the Lost River at Olene was inundated by the construction of Wilson Dam in 1912. Spawning habitat at Big Springs has been modified by development of a city park and made inaccessible by seasonal dams installed during the irrigation season. Sucker spawning has also been documented in Miller Creek, a tributary to the Lost River. The lower 3 miles of Miller Creek have been channelized and flow restricted during the irrigation season.

Numerous dams are located on the Lost River including Clear Lake, Malone, Big Springs, Harpold, Lost River Ranch, Wilson, and Anderson-Rose. None have fish passage facilities although some are removed after the irrigation season. A number of small pumping plants are also withdrawing water from the Lost River. Reclamation documented 132 diversions in 1998 in the Lost River very few of which have screens or other modifications to reduce or minimize fish entrainment except for the largest fish (USBR 2000). There are also many drains that receive irrigation return flows that discharge into the river. Unscreened UKL water is diverted into the Lost River at several locations, and Lost River water can be diverted to the Klamath River via the Lost River Diversion Canal. Consequently flows are highly modified both in timing, quantity, and quality (Orlob and Woods 1964). The Lost River was historically connected to the

Klamath River during high flows via the Lost River Slough. The Lost River Diversion Canal was constructed at the location of that slough.

Owing to irregular irrigation withdrawals from the Lost River, water levels in the river may rapidly fluctuate leading to bank instability and slumping and fish habitat quality is much reduced. Flows in the upper reaches of the Lost River, from the Clear Lake Dam to the confluence of Rock Creek, are cut off from October to April during the non-irrigation season, with the only flows coming from accretion primarily by small springs and Rock Creek. During this time, fish are confined to any remaining pools and are thus likely subjected to high predation, a lack of food, and poor water quality (Koch and Contreras 1973). DO levels measured in September 1999 after flows were cutoff at Clear Lake Dam were <4 mg/l in pools (USBR unpublished data). Downstream reaches such as below Malone Dam have much reduced flows in summer as water is diverted from the river into West Canal, and Miller Creek flows are diverted to North Canal.

The highly modified nature of the Lost River is expressed in its aquatic fauna, which include many non-native, warm-water species (Koch and Contreras 1973). In 1999, USGS documented 21 fish species including 13 non-natives. Fathead minnows were the predominant species captured in most areas (BRD 2000). Koch and Contreras (1973) and BRD (2000) identified several distinct river segments, based on fish distribution and abundance and habitat condition: 1) upper Lost River above Malone Dam with relatively high fish diversity, good water quality and high habitat diversity; 2) upper Lost River, upstream of Bonanza, which has lower fish numbers because of channelization and shallow depths owing to water diversions; 3) Big Springs to Harpold Dam which contains the best fish habitat owing to significant input of spring water and suitable habitat; 4) Harpold to Olene with substantial channelization and lack of habitat diversity, 5) Wilson Reservoir above Lost River Diversion Dam which has a relatively high diversity of fish; and 6) lower Lost River, characterized by low fish diversity.

Tule Lake is only 10-20% of its historic size, is very shallow owing to wind and water-borne sedimentation, has relatively constant water levels, and degraded summer-time water quality. Suckers are restricted to small areas of deep water in the summer.

SNS in the Lost River system are atypical and resemble KLS, and have adapted to conditions in streams and small reservoirs there. Andreasen (1975) did find evidence of SNS X KLS introgression in the Lost River system because those suckers were positioned in the discriminant analysis between SNS and KLS from UKL. Koch et al. (1975) however, suggested the SNS population from the Lost River watershed was different as a result of isolation rather than hybridization. Buettner and Scoppettone (1991) found that SNS from the Clear Lake and Upper Klamath drainages differed in a number of characters including: gill raker and lateral line scale numbers, head shape, lip morphology, and others. They suggested these differences could be the result of: (1) morphological divergence; (2) genetic drift; or (3) introgression. Buettner and Scoppettone (1991) postulated that genetic drift may have resulted from isolation or the morphological differences are due to a phenotypic response to different environments, since habitat/hydrological conditions are different in the Lost River and

Williamson/Sprague watersheds. This latter explanation is similar to the ecophenotypic concept of Markle et al 2000. Genetic studies by Tranah (2001) point to introgression as being especially evident in Lost River SNS and KLS populations; however, this does not rule out other processes working in the Lost River system to affect sucker morphology as discussed above.

Sucker spawning habitat in the Lost River is very limited. Sucker spawning has been documented below Anderson-Rose Dam, in Big Springs, and at the terminal end of the West Canal as it spills into the Lost River, and lower Miller Creek. Suspected spawning areas that have suitable habitat include the spillway area below Malone Reservoir, just upstream of Keller Bridge, just below Big Springs, just below Harpold Dam and adjacent to Station 48.

Water quality conditions are frequently stressful in the Lost River during the summer. In 2003, an adult sucker die-off occurred in Harpold Reservoir due to low dissolved oxygen and water temperatures. A juvenile sucker die-off was documented in Wilson Reservoir in 1998 owing to low dissolved oxygen under ice-cover (Reclamation unpublished data).

Upstream and downstream fish passage would be justified in the reach from Bonanza to Lost River Ranch because sucker populations are largest there and habitat including water quality is relatively good with substantial accretions from Big Springs and Buck Creek. Also, construction costs associated with these low-head dams is relatively low. Passage may allow fish better access to water quality refuge areas near Bonanza during the summer.

Passage at the larger diversion dams Wilson and Anderson Rose are not justified at the present time because of the low population size, poor summer water quality and lack of available spawning habitat that would be available upstream. Passage at Malone Dam is not justified because of the apparent lack of adult fish that might use it.

Installation of fish screens on diversions in the Lost River are probably not justified at the present time because other factors are limiting population size including adult rearing habitat and water quality.

With respect to the Lost River Diversion Canal, keeping fish from the Lost River from being entrained into the Klamath River is not a priority because the number of suckers entrained is likely low particularly for juveniles and adults. Again, lack of rearing habitat is probably the primary limiting factor in the Lost River. Allowing suckers from the Lost River to move to the Klamath River allows for connectivity of sucker populations. Minimization of sucker entrainment from the Klamath River to the Lost River may be justified because rearing habitat in the lower Lost River and Tule Lake are limited. Also, numbers of suckers available to be entrained are large due to entrainment of suckers from Link River Dam. Installation of the A-Canal fish screen in 2002 has likely resulted in a significant increase in entrainment at Link River Dam. Also, the Lake Ewauna area has the best habitat and supports the highest densities of suckers in the Keno Impoundment. Currently, poor summer-time water quality conditions are likely the major limiting factor

for survival in the Klamath River. Even if the Lost River Diversion Canal is screened, entrainment of larval suckers will continue to occur. Some entrainment will also occur during the transition periods when the screens are not in place. For example, during the fall and winter when water flows from the Lost River to the Klamath River the screen will be removed and suckers from the Klamath River could move into the canal. Then when flows are reversed and screens operated, fish holding in the canal could be entrained into the Lost River. This number of entrained fish would likely be sufficient to seed Tule Lake under the existing conditions.
During the fall and winter trash racks should be operated to prevent adult suckers and trout from moving into the Lost River Diversion Canal. Again the rationale is that there is limited habitat to support them in the Lost River and no passage facilities to allow volitional movement.

Although screening of the Lost River Diversion canal is not biologically justified at the present time because it is not the primary limiting factor for fish in the Keno Reservoir, Reclamation has an obligation to minimize take as a result of operation of the Klamath Project. Screening this diversion reduces the need for screens at Miller Hill Pumping Plant, Station 48, and J-Canal. Reclamation also has a requirement to screen its diversions under State of Oregon statutes. Screening may also reduce the risk of third-party lawsuits and set the stage for additional habitat and water quality restoration actions in the Klamath River. Reclamation has secured funding for its fish passage program for the next several years. If it is not obligated now, it might not be available in the near future. This project would also benefit future fish recovery programs including reintroduction of anadromous fish in the Upper Klamath Basin. Screening the Lost River Diversion Canal might also help prioritize restoration of habitat and water quality in Lake Ewauna.

All Ecoregions	194	
Owner	#	%
BEATY	3	1.5%
BUREAU OF LAND MANAGEMENT	18	9.3%
FRUIT GROWERS SUPPLY	3	1.5%
HANCOCK	1	0.5%
HOOPA VALLEY RESERVATION	1	0.5%
KLAMATH NF	20	10.3%
LASSEN NF	11	5.7%
LASSEN VOLCANIC NP	2	1.0%
MODOC NF	31	16.0%
OTHER PRIVATE	53	27.3%
ROGUE RIVER NF	1	0.5%
ROSEBURG	2	1.0%
SHASTA-TRINITY NF	29	14.9%
SIERRA PACIFIC INDUSTRIES	11	5.7%
SISKIYOU NF	1	0.5%
SIX RIVERS NF	5	2.6%
TULE LAKE NWR	2	1.0%

Federal	120	61.9%
Timber Company	20	10.3%
Other Private	53	27.3%
Indian	1	0.5%

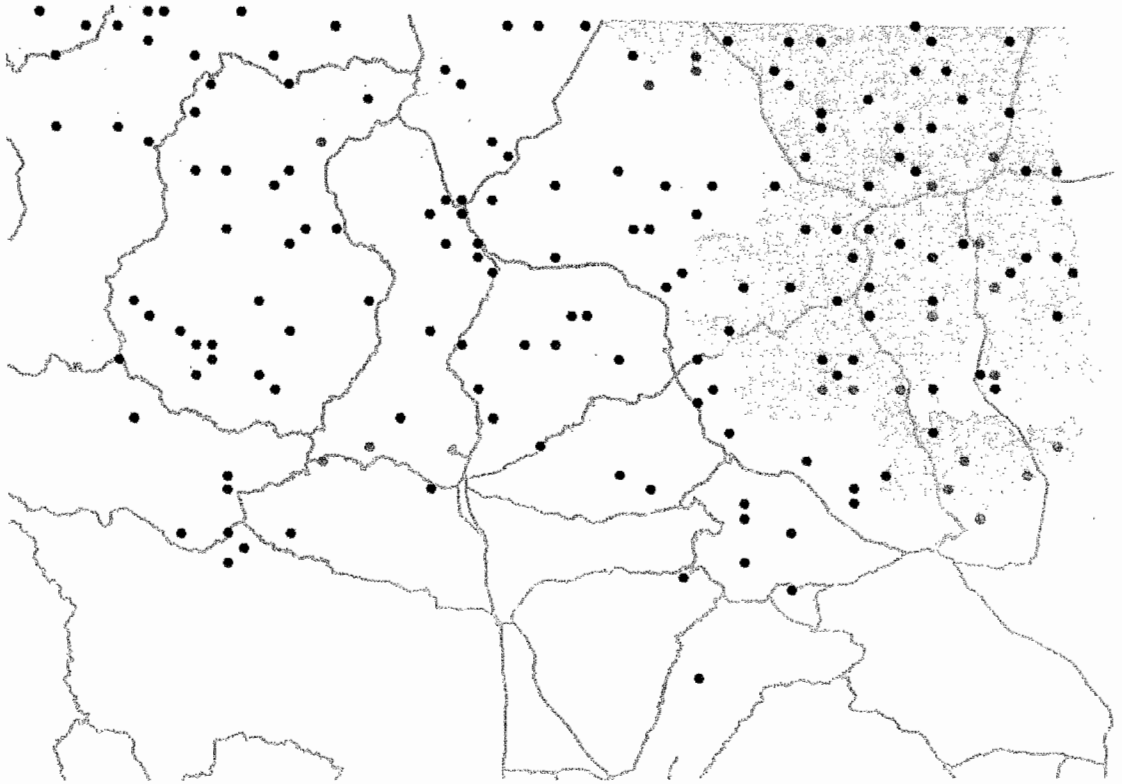
Key

Forest Serivce	**Dark Green**
BLM	**Light Green**
NWR	**Blue**
Indian	**Pink**
Timber Company	**Yellow**
Other Private	**Red**

Klamath Ecoregion	69	
Owner	#	%
BUREAU OF LAND MANAGEMENT	3	4.3%
FRUIT GROWERS SUPPLY	2	2.9%
HOOPA VALLEY RESERVATION	1	1.4%
KLAMATH NF	19	27.5%
PRIVATE	14	20.3%
ROGUE RIVER NF	1	1.4%
SHASTA-TRINITY NF	22	31.9%
SIERRA PACIFIC INDUSTRIES	1	1.4%
SISKIYOU NF	1	1.4%
SIX RIVERS NF	5	7.2%

Southern Cascades Ecoregion	55	
Owner	#	%
BEATY	2	3.6%
BUREAU OF LAND MANAGEMENT	1	1.8%
FRUIT GROWERS SUPPLY	1	1.8%
HANCOCK	1	1.8%
KLAMATH NF	1	1.8%
LASSEN NF	9	16.4%
LASSEN VOLCANIC NP	2	3.6%
MODOC NF	2	3.6%
PRIVATE	19	34.5%
ROSEBURG	2	3.6%
SHASTA-TRINITY NF	7	12.7%
SIERRA PACIFIC INDUSTRIES	8	14.5%

Modoc Ecoregion	70	
	#	%
BEATY	1	1.4%
BUREAU OF LAND MANAGEMENT	14	20.0%
LASSEN NF	2	2.9%
MODOC NF	29	41.4%
PRIVATE	20	28.6%
SIERRA PACIFIC INDUSTRIES	2	2.9%
TULE LAKE NWR	2	2.9%



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ROSEBURG	2	1.0%
SHASTA-TRINITY NF	29	14.9%
SIERRA PACIFIC INDUSTRIES	11	5.7%
SISKIYOU NF	1	0.5%
SIX RIVERS NF	5	2.6%
TULE LAKE NWR	2	1.0%

Federal	120	61.9%
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Indian	1	0.5%

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KLAMATH NF	19	27.5%
PRIVATE	14	20.3%
ROGUE RIVER NF	1	1.4%
SHASTA-TRINITY NF	22	31.9%
SIERRA PACIFIC INDUSTRIES	1	1.4%
SISKIYOU NF	1	1.4%
SIX RIVERS NF	5	7.2%

Southern Cascades Ecoregion	55	
Owner	**#**	**%**
BEATY	2	3.6%
BUREAU OF LAND MANAGEMENT	1	1.8%
FRUIT GROWERS SUPPLY	1	1.8%
HANCOCK	1	1.8%
KLAMATH NF	1	1.8%
LASSEN NF	9	16.4%
LASSEN VOLCANIC NP	2	3.6%
MODOC NF	2	3.6%
PRIVATE	19	34.5%
ROSEBURG	2	3.6%
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Modoc Ecoregion	70	
	#	**%**
BEATY	1	1.4%
BUREAU OF LAND MANAGEMENT	14	20.0%
LASSEN NF	2	2.9%
MODOC NF	29	41.4%
PRIVATE	20	28.6%
SIERRA PACIFIC INDUSTRIES	2	2.9%
TULE LAKE NWR	2	2.9%