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Riverine movements of adult Lost River, shortnose, and Klamath largescale suckers in the Williamson and Sprague rivers, Oregon.

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Abstract

Chiloquin Dam, constructed in 1914, is located at river kilometer (rkm) 1.3 on the Sprague River near the town of Chiloquin, Oregon. The dam has been identified as a barrier that potentially inhibits or prevents the upstream movement of fish in the Sprague River of the Upper Klamath Basin. Dam removal has recently been recommended by a technical working group as the preferred alternative to remedy fish passage problems at the dam. Our research objectives in 2004 were to identify adult catostomid spawning areas above Chiloquin Dam and describe adult migration patterns to and from these areas in the Sprague River prior to any action taken to improve fish passage at Chiloquin Dam. In 2004, we attached external radio transmitters to 25 Klamath largescale suckers (*Catostomus snyderi*), 20 Lost River suckers (*Deltistes luxatus*), and 9 shortnose suckers (*Chasmistes brevirostris*) at the Chiloquin Dam fish ladder. Tagged individuals were released above the dam. Our efforts to locate tagged individuals indicated that shortnose suckers did not migrate above Chiloquin Narrows (rkm 10 to 13) in the Sprague River. Klamath largescale and Lost River suckers both migrated to Beatty Gap (rkm 112 to 120) and the Nine Mile area (rkm 13 to 46) with the earliest tagged individuals generally traveling the furthest upstream. Several individuals of all three species were located only near Chiloquin Dam with some being first located below the dam following their release. Both upstream and downstream migrations were variable in duration for individuals of all three species.

Introduction

Chiloquin Dam, constructed in 1914, is located at river kilometer (rkm) 1.3 on the Sprague River near the town of Chiloquin, Oregon. The dam currently serves as a diversion point to supply irrigation water for the Modoc Point Irrigation District. The dam has been identified as a barrier that potentially inhibits or prevents the upstream movement of Lost River suckers (*Deltistes luxatus*; LRS), shortnose suckers (*Chasmistes brevirostris*; SNS), Klamath largescale suckers (*Catostomus snyderi*; KLS), and other fish species in the Sprague River of the Upper Klamath basin (U.S. Fish and Wildlife Service (USFWS) 1993, National Research Council 2003). During the dam's history, it has been fitted with three fish ladders to aid in fish passage. At present, the dam has only one functional fish ladder on the right riverbank. The present fish ladder was built in 1966 and has since been modified with baffle boards to provide better passage for catostomids. The ladder consists of a series of 10 concrete pools with an average drop of approximately 0.3 m between each pool. Since 1975, the ladder has been periodically surveyed by state, federal, and tribal agencies for the presence of redband trout (*Oncorhynchus mykiss* ssp.) and catostomids.

Relatively little empirical information exists regarding the historic distribution and extent of spawning areas used by catostomids in the Sprague River above Chiloquin Dam. Lost River suckers have been observed spawning in Kirk Spring (rkm 111.4), near the town of Beatty, Oregon (L. Dunsmoor, The Klamath Tribes, pers. comm.). Furthermore, juvenile LRS and KLS have been collected from the Sycan River above the confluence with the Sprague River (rkm 107) indicating possible spawning in this portion of the Sprague River drainage as well (M. Buettner and F. Weekly, USFWS, pers. comm.). For LRS, Perkins et al. (2000) suggested there may be an early run that spawns in the upper Sprague River and a later run that spawns in the Williamson and lower Sprague rivers. A genetically unique group of KLS passing through the ladder early in the year has also been identified (D. Markle, Oregon State University, pers. comm.) suggesting distinct runs of KLS may exist in the Sprague River system as well.

In 2000, the U.S. Geological Survey (USGS) implemented an intensive routine sampling program at the Chiloquin Dam fish ladder to monitor composition, timing, and

relative abundance of the catostomid spring spawning runs in the Sprague River as part of a larger effort to monitor adult LRS and SNS population status in the Upper Klamath Basin (Shively et al. 2001). Regular sampling of the fish ladder has shown that the numbers of the three catostomid species entering the fish ladder are variable between years (Figure 1). Perkins et al. (2000) observed that increasing water temperature may be an important cue for upstream migration of catostomids in the Sprague and Williamson rivers. Other factor such as instream flow conditions and length of daily photoperiod may also influence catostomid migration in the Sprague River. The efficiency of the Chiloquin Dam fish ladder to pass catostomids and the extent they are able to find, enter, and negotiate the ladder, however, are still largely unknown.

Earlier telemetry studies provided some description of catostomid spawning migrations within the Williamson-Sprague river system. Lost River and SNS have also regularly been observed spawning immediately below Chiloquin Dam during their spring spawning runs. Work conducted in the 1980's by the Klamath Tribes and Oregon Department of Fish and Wildlife documented some movement of catostomids across Chiloquin Dam in the spring and presumably this movement was associated with spawning activity (C. Bienz, The Nature Conservancy (TNC), pers. comm.). During this study, several KLS, LRS, and SNS were fitted with radio transmitters to determine timing and extent of their spawning runs. Five KLS were captured, tagged, and released near the Williamson River mouth on Upper Klamath Lake (UKL) in October and appeared to begin their upstream migration in December. Four tagged KLS moved through the Chiloquin Dam fish ladder in February and March and were located in the Nine Mile area between the top of Chiloquin Narrows (rkm 13) and the bottom of S'Ocholis Canyon (rkm 46). During the same study, four LRS were captured, tagged, and released at Chiloquin Dam in April and located near Kirk Spring (rkm 111.4) within a few weeks after being released. Three SNS were also captured, tagged, and released near the Williamson River mouth on UKL in October and were located in January near the Highway 97 Bridge (rkm 11.2). In April, the tagged SNS moved upstream through the ladder at Chiloquin Dam to rkm 23 (immediately downstream of Copperfield Draw), where they apparently spawned in side channels of the Sprague River (C. Bienz, TNC, pers. comm.).

Buettner and Scoppettone (1990) fitted several LRS, SNS, and KLS with radio transmitters and monitored their movements in 1987 and 1988. As part of this study, tagged fish were monitored as they entered the Chiloquin Dam fish ladder. No LRS or SNS passage through the fish ladder was observed, although a few tagged fish were observed in the ladder's lower cells. In 1987, 17 LRS and six SNS were fitted with radio transmitters. These fish were electrofished from the lower Sprague and Williamson rivers and released at several locations in the lower river system below Chiloquin Dam. Seven LRS appeared to return to UKL immediately after being tagged while 10 remained in the lower river system for 6 to 16 days. Several of these fish were located at the base of Chiloquin Dam, but none were detected in the ladder. All six SNS apparently shed their tags within 48 hours, presumably because of weak tag-attachment sutures. One SNS was noted to have moved 6 rkm upstream from its release site in the Williamson River to the base of Chiloquin Dam during the first 24 hours before shedding its tag. Tags were also attached to eight KLS collected in the fish ladder (two in 1987 and six in 1988) and were released immediately upstream of the dam. One KLS tagged in 1987 and four tagged in 1988 shed their tags immediately following their release. The remaining KLS tagged in 1987 moved above the dam 79 rkm and remained in the river for 28 days. The two KLS tagged in 1988 were located upstream of the dam, one at rkm 11 at the base of Chiloquin Narrows and the other at rkm 129 in the Beatty Gap area. These fish remained in the river for 16 and 22 days, respectively. Additional data collected from 1993 to 1996 indicated that most of the catostomids tagged (three of four LRS and eight of nine SNS) spent at least two to three weeks in the Williamson-Sprague watershed. Downstream movement of tagged catostomids may have only been a few days (M. Buettner, USFWS, unpublished data).

By a provision in the 2002 U.S. Farm Bill, the U.S. Bureau of Reclamation was authorized to study the feasibility of improving fish passage at Chiloquin Dam. Through this provision, a technical working group was formed and reached consensus that dam removal was the recommended fish passage alternative. Although existing data suggests some fish species may be able to successfully negotiate the existing fish ladder in some years, removal of this dam was expected to improve access of all fish species in the Williamson-Sprague watershed to upstream spawning and rearing habitat. The amount of

suitable habitat and the extent that fish populations will use habitat upstream of the dam, however, remains unknown.

This study was designed to investigate the current status of upstream, presumably spawning, migrations of the three catostomid species attempting to cross Chiloquin Dam through the existing fish ladder. Our objectives in 2004 were to identify adult catostomid spawning areas and describe adult migration patterns to and from these areas in the Sprague River prior to any action taken to improve fish passage at Chiloquin Dam. Findings from this study may prove beneficial in assessing changes in distribution and migratory behavior of catostomids in the Sprague River following efforts to improve fish passage at the dam.

Methods

In spring 2004, 25 KLS, 20 LRS, and 9 SNS were captured at the Chiloquin Dam fish ladder, fitted with external radio transmitters, and released immediately upstream of the dam. Initially we had proposed to fit 25 of each species with transmitters, but reduced availability of LRS and SNS in the fish ladder during spring 2004 limited our ability to tag more individuals.

Adult catostomids selected for transmitter attachment were all in prespawn condition (no expression of gametes when lightly squeezed) and were primarily unmarked in USGS adult monitoring efforts as indicated by a lack of a passive integrated transponder (PIT) tag. Several previously PIT tagged prespawn LRS and SNS were fitted with radio transmitters in May as the number of catostomids in the fish ladder declined. Each fish was identified to species, sex, and spawning condition, measured for fork length, and inserted with a PIT tag prior to the attachment of a transmitter. Species determination for each fish was based on morphological characteristics as described in Cavalluzzi and Markle (2000). In addition, a tissue sample was collected from each fish so a genetic analysis could be conducted at a later date should it be deemed necessary to do so. These fish were fitted with the Pisces radio transmitter manufactured by Grant Systems Engineering. The Pisces tag is a small submersible tag measuring approximately 30 x 10 x 10 mm. The internal components of each tag were sealed in a foam epoxy resulting in a nearly neutrally buoyant tag weighing approximately 2.0 g in

air and 0.2 g in water. The foam epoxy surrounding the tags was colored grey to mimic the dorsal coloration of the fish. Battery life of each tag was estimated by the manufacturer to be approximately four to six weeks with a signal burst set at every 5 seconds. Tags were programmed to transmit on four different frequencies ranging from 164.290 MHz to 164.350 MHz with each tag set to generate a coded identifier unique to each fish transmitting on that frequency. Field tests for these tags showed that codes could be received at a distance of approximately 100 m at river level and approximately 600 m from a plane flying at 300 m elevation.

Each fish to be fitted with a radio transmitter was first lightly anesthetized with 1 part Tricaine Methane Sulfonate (MS-222) to 1000 parts river water. The radio transmitters were attached externally to the fish behind the dorsal fin by threading anchor material (18-lb test nylon-coated, seven-strand stainless steel wire or monofilament) through the dorsal musculature with a 15.2 mm, 14 gauge Rosenthal needle. Needles were used to pass the anchor material through each fish twice for a double-posted attachment technique. One end of the anchor material was crimped with a brass sleeve behind a 6.4-cm^2 plastic backer. The other end of the anchor material was crimped with a piece of inferior wire behind a similar backer with the expectation of the crimp eventually corroding, thereby causing the tag to release from the fish. Nylon-coated stainless steel wire was initially used to attach tags to the first 22 catostomids (18 KLS and 4 LRS). We switched to 25-lb monofilament for all subsequent fish when we suspected premature tag loss was a result of using the nylon-coated wire. Further investigation with the nylon-coated wire indicated the crimped brass sleeves damaged the nylon coating which allowed it to slip from the multi-strand wire. Each tagged fish was allowed to recover in a holding tank with a dilute amount of StressCoat® antibacterial solution for 30 to 60 min prior to release 100 m upstream of Chiloquin Dam.

Movements of approximately 120 adult catostomids that had been tagged and released in UKL as part of a concurrent USGS study were also monitored in conjunction with fish tagged at Chiloquin Dam. During this study, the additional tagged fish from UKL were monitored for movements from the lake into the lower Williamson and Sprague rivers.

Surveys for tagged fish were conducted from a fixed-wing aircraft on a weekly basis. Aerial surveys focused on the north end of UKL, the lower Williamson River, and the Sprague River watershed. During a typical aerial survey, the aircraft would pass over the northeast shoreline of UKL, the Williamson River up to its confluence with Spring Creek, the Sprague River, and the lower portions of major tributaries to the Sprague River up to the first fish barrier. Major tributaries of the Sprague River including the Sycan River, Spring Creek, North and South Forks of the Sprague River, Deming Creek, and Meryl Creek were included in the aerial survey. In areas where aerial surveys indicated tagged fish were concentrating, a ground survey was conducted to confirm presence and more precisely locate fish.

Results

Klamath Largescale Sucker

Of the 25 KLS that were tagged, 23 individuals were captured between 3 March and 26 March 2004 (Table 1). During this time, 1263 KLS were captured in monitoring at the Chiloquin Dam fish ladder (E. Janney, USGS, unpublished data). The other two KLS were tagged on 9 April 2004. Between 2 April and 12 May 2004, only 103 KLS were captured in monitoring at the fish ladder (E. Janney, USGS, unpublished data). The 23 individuals tagged during the first peak consisted of 11 females and 12 males (Table 1). The remaining two fish tagged were both female. Mean fork length of all KLS tagged in 2004 was 470.4 mm (SD, 34.4) for 13 females and 441.0 mm (SD, 13.6) for 12 males.

Radio-tagged KLS were located in the lower Sprague and Williamson rivers, in Beatty Gap (rkm 112 to 120), and in the Nine Mile area (rkm 13 to 46). Weekly tracking located 10 tagged KLS (KLS-1 through KLS-10) in the impoundment above the dam (rkm 2 to rkm 3) on a regular basis (Figures 2 and 5, Table 1). Very little movement of these fish was detected in the impoundment and we believe many shed their tags soon after release. Several fish in this group, however, may have retained their tags and showed limited movement within the impoundment area over several weeks. All but two of these fish were tagged the first week of the study and all had tags affixed with nylon-

coated wire. We located KLS-10 only once in the impoundment five days following its release.

We located five KLS (KLS-11 through KLS-15) in Beatty Gap (rkm 112 to 120) on the Sprague River 12 to 16 days after release (Figures 2 and 5, Table 1). Surveys did not locate any of these fish the week following release or at any point of their upstream migration between Chiloquin Dam and Beatty Gap. Three of these fish (KLS-13, KLS-14, and KLS-15) were located on their downstream migration three to four weeks following their release. One of these fish appeared to have shed its tag on its downstream migration in the Nine Mile area at rkm 32. The two remaining fish of this group (KLS-11 and KLS-12) appeared to have either remained in Beatty Gap until their tags stopped transmitting or they possibly shed their tags while spawning.

One KLS (KLS-16) was located at in the Nine Mile area at rkm 38 (near Kamkaun Spring) and two KLS (KLS-17 and KLS-18) were located below U.S. Forest Service (USFS) Road 5810 at rkm 6 during consecutive surveys following release (Figures 2 and 5, Table 1).

Due to the rapid movement of these fish on their spawning migrations, we were unable to adequately track many of the KLS we released. Two KLS (KLS-19 and KLS-22) were located in the lower Williamson River 4-5 weeks after release where they remained until their tags stopped transmitting. One fish (KLS-21) was only located twice, first above Chiloquin Dam (rkm 2) 8 days after release and again a week later below Chiloquin Dam at rkm 1. Another fish (KLS-23) was first located below Chiloquin Dam 10 days following release and later contacted several times at the base of Chiloquin Dam. Another fish (KLS-20) was first located at rkm 4 in the lower Williamson River 50 days after release. This fish remained in the same relative area until its tag stopped transmitting approximately three weeks later. The intact, but no longer transmitting, tag rig (tag, wire, and backers) for KLS-20 was found 72 days after release in a USGS trammel net set off Silver Building Springs along the eastern shore of UKL approximately 2 weeks after it was last contacted in the Williamson River. One fish (KLS-24) was only contacted in UKL following release. One fish (KLS-25) was not located following release (Table 1).

Lost River Sucker

Only 280 LRS were captured in the Chiloquin Dam fish ladder in 2004 (Figure 1). Of the 20 LRS that were fitted with radio transmitters, eight were selected from 57 LRS captured in the fish ladder between 3 March and 26 March 2004. The other 12 fish we tagged were selected from 223 LRS captured in the fish ladder from 5 April to 17 May 2004. The first eight LRS we tagged consisted of six females and two males. The remaining 12 included six females and six males. Mean fork lengths of tagged LRS were 619.0 mm (SD, 28.1) for females and 562.5 mm (SD, 27.2) for males.

Lost River suckers radio-tagged from Chiloquin Dam in 2004 were located in the lower Williamson and Sprague rivers, in the Nine Mile area, and Beatty Gap. The earliest tagged fish at the dam appeared to travel the furthest upriver with four LRS tagged at the ladder in March through early April later located in Beatty Gap. Two LRS were located only as far upstream as the Nine Mile area with an additional LRS located in the Sprague River Valley between the Nine Mile area and Beatty Gap. Upstream and downstream migration duration appear variable between individuals.

Weekly tracking above Chiloquin Dam located six LRS (LRS-1 through LRS-6) in the impoundment above the dam on a regular basis (Figures 3 and 5, Table 2). No noticeable movement of these fish in the impoundment was detected indicating these fish shed their tags soon after release. We affixed tags with Nylon-coated wire on four of these fish (LRS-1 through LRS-4) while LRS-5 and LRS-6 had tags affixed with monofilament.

Four LRS (LRS-7 through LRS-10) were contacted in Beatty Gap on days 11 through 27 after release (Figures 3 and 5, Table 2). Three of these fish (LRS-7, LRS-8, and LRS-9) were part of the first group of LRS to enter the ladder during the first and second weeks of the study in March and consisted of two females and one male. Another fish (LRS-10), a female, was part of the second pulse of LRS to enter the ladder during the fourth week of the study in early April. One fish (LRS-7) was contacted on its upstream migration near the town of Sprague River (rkm 82) on the 11th day after release before reaching Beatty Gap area. Two LRS (LRS-7 and LRS-8) appeared to have remained in Beatty Gap at rkm 117 and rkm 119, respectively, for at least three weeks until their tags presumably stopped transmitting. Another fish (LRS-9) was located in

Beatty Gap at rkm 117 on the 16th day after release and was not contacted again until the 35th day after release when it was found in UKL near the mouth of the Williamson River. This LRS remained in this portion of UKL for at least three weeks until its tag stopped transmitting. The last LRS contacted at Beatty Gap (LRS-10) remained in the impoundment above Chiloquin Dam at rkm 3 for at least ten days after release. This fish was then contacted in Beatty Gap at rkm 118 on the 18th day after release and was last located near Kamkaun Spring at rkm 38 on the 24th day after release.

One LRS released during second week of the study (LRS-11), was first located 12 days after release near Lone Pine at rkm 55 (Table 2). This LRS was not located again until 34 days after release when it was found at rkm 70. On the 43rd day after release this LRS was located a final time above Chiloquin Dam at rkm 3. Two LRS (LRS-12 and LRS-13) were contacted as far upstream as the Nine Mile area (Figures 3 and 5, Table 2). One fish, tagged the second week of the study (LRS-12), was located the Nine Mile area 23 days after release where it presumably shed its tag. This fish was located weekly at this location until its tag stopped transmitting after 18 May 2004. Another LRS from a different tagging week at the fish ladder (LRS-13) was located in the Nine Mile area on the 13th day after release. This fish was located again in the impoundment above Chiloquin Dam at rkm 3 on the 21st and 26th day after release.

Five LRS we tagged and released above Chiloquin Dam were briefly located in the lower Sprague River between the USFS Road 5810 bridge at rkm 10 and UKL (Table 2). One fish (LRS-14) was released the seventh week of the study and located between the impoundment and USFS Road 5810 at rkm 4 on the 6th day after release, but was not located again. LRS-15 was released the fourth week of the study and located 26 days after release in the same general area at rkm 5. It remained at this location until the sixth week after release when its tag presumably stopped transmitting. Two LRS (LRS-16 and LRS-17) were released on the fourth week of the study and only located once during the study. One (LRS-16) was located at the base of Chiloquin Dam four days after release and the other (LRS-17) was found in the lower Williamson River below the confluence of the Sprague River at rkm 16 on the 10th day after release. One fish (LRS-18) was released on the seventh week of the study and located only once, 22 days after release, in UKL west of the Williamson River mouth. Two other LRS (LRS-19 and LRS-20) were

released on the seventh and eighth weeks of the study and were never located during this study (Table 2).

Shortnose Sucker

Only 21 SNS were captured in the Chiloquin Dam fish ladder in 2004 (Figure 1). Of these 21, nine were fitted with transmitters on four dates (28 and 30 April 2004, and 3 and 5 May 2004). The mean fork length was 433.3 mm (SD, 25.2) for 7 female SNS and 435.5 mm (SD, 41.7) for the 2 male SNS tagged in 2004.

None of the SNS fitted with transmitters at the fish ladder in 2004 traveled upstream further than a few river kilometers above Chiloquin Dam. Two SNS (SNS-1 and SNS-2) were both located at rkm 4 on the 2nd day after release (Figures 4 and 5, Table 3). These fish were not located again during this study. A third SNS (SNS-3) was located in same general area at rkm 3 on the same day as its release. The following week this fish was located for the last time above Chiloquin Dam at rkm 2. Another SNS (SNS-4) was located below USFS Road 5810 at rkm 5 during the first week after release. The tag from SNS-4 was located on the riverbank among remains of several fish the following week.

Three other SNS (SNS-5 through SNS-7) were contacted above Chiloquin Dam at rkm 2 following their release (Table 3). One fish (SNS-5) appears to have remained in the impoundment for approximately two weeks after release while the remaining two fish (SNS-6 and SNS-7) appear to have remained for less than one week. None of these fish were relocated after they moved from the impoundment.

Two fish (SNS-8 and SNS-9) were contacted above Chiloquin Dam at rkm 2 and rkm 3 after release (Table 3). These fish were located repeatedly for 3 to 4 weeks in the same area and it appeared that both fish shed their tags soon after release.

Other tagged LRS and SNS from UKL

In 2004, 56 LRS and 64 SNS had been implanted with internal transmitters and released in UKL to study the affects of water quality on adult catostomid behavior in UKL (B. Adams, USGS, unpublished data). We attempted to track these fish in the lower Williamson and Sprague rivers during weekly aerial surveys of the watershed. Due

to the number of fish tagged on different frequencies entering the watershed, we were not always able to distinguish individual fish from the aerial surveys. Although none of these tagged individuals were located above the Sprague River dam, 38 were located in the lower Williamson and Sprague rivers in 2004.

We first located fish from the behavior study on 30 March 2004, when 2 fish were detected in the lower Williamson River downstream of US Highway 97. On 6 April 2004, another 15 adult catostomids were detected in the lower Williamson and Sprague rivers distributed from Chiloquin Dam downstream to UKL. On 13 April 2004, 6 individuals were located in the same stretch of both rivers. Four of the six fish had been located in the rivers during the previous week's survey of the area. The number of adult catostomids in the lower reaches of both rivers increased to 14 on 21 April 2004, three of which were observed in these areas during the previous week. On 27 April 2004, 12 adult catostomids were located in the lower river reaches, three of which were observed in these areas during the previous week. On 3 and 12 May 2004, five catostomids each week were located in the lower reaches of both rivers.

Discussion

Results from tracking of adult catostomids captured at the Chiloquin Dam fish ladder in spring 2004 indicate that certain reaches of the Sprague River upstream of the dam may be important spawning and holding areas for KLS, LRS, and SNS. Of the radio-tagged catostomids that were released upstream of the dam, nine were located in the Beatty Gap area (rkm 112 to 120) and three were located in the Nine Mile area (rkm 13 to 46). Two of the nine catostomids contacted upstream in the Beatty Gap area were found in the following weeks in the Nine Mile area during their downstream migration. No spawning activity was observed while tracking fish because of the turbidity of the water in the main channel where all of the radio-tagged suckers were located.

Travel times for individual fish were difficult to measure given infrequent repeat contacts with fish in 2004. Although data is lacking to make generalizations regarding the catostomid movements for this year, we did locate several KLS and LRS that exhibited rapid upstream migration from the release site at Chiloquin Dam to Beatty Gap.

As indicated by at least one LRS, post-spawn emigration from the upstream spawning areas to UKL may also be relatively rapid.

Klamath Largescale Sucker

Five KLS were located in Beatty Gap 12 to 16 days following their release at Chiloquin Dam. It was not clear from this study if these KLS returned to the lower watershed or UKL after their leaving Beatty Gap. Several other KLS were located in the lower Williamson and Sprague rivers following their release but it is uncertain if they were spawning in area or if they were individuals migrating downstream after spawning somewhere upstream. An additional five KLS returned to the lower Williamson River and one KLS was located in UKL after tagging and release at Chiloquin Dam. It is unknown, however, how far upstream these fish migrated as none were located above Chiloquin Dam.

Adult KLS movement to Betty Gap was presumably for the purpose of spawning in this area. A concurrent study by USGS in 2004 to monitor larval catostomid emigration in the Williamson-Sprague watershed recorded a relatively large pulse of larval catostomids at Godowa Spring Road on the Sprague River (rkm 108) approximately two weeks after adult KLS were located in Beatty Gap (T. Tyler, USGS, unpublished data). Aggregations of adult catostomids in this area followed by the occurrence of relatively abundant numbers of larval catostomids just downstream suggests there is significant spawning activity by KLS in the Beatty Gap area. Previous studies have indicated that KLS from the lower reaches of the Williamson-Sprague watershed migrate to this area (Buettner and Scoppettone 1990, C. Bienz, TNC, pers. comm.), but this is the first study to demonstrate larval production in association with these catostomid migrations.

Contacts with radio-tagged KLS in 2004 indicate spawning areas for KLS may occur at discrete locations in the upper and lower watershed. Several adult KLS passed above the fish ladder at the Chiloquin Dam and migrated rapidly to areas over 100 rkm upstream. Several other tagged KLS in 2004 returned to areas in the Sprague and Williamson rivers below the Chiloquin Dam without making a detectable upstream migration. Klamath largescale sucker migration corridors and spawning areas appeared

to principally occur within the mainstem of the Williamson and Sprague rivers. Downstream migration of KLS appears to have occurred rapidly and included termination at Upper Klamath Lake, and at both the lower Sprague and lower Williamson rivers.

Lost River Sucker

Radio-tagged LRS were distributed in three general areas in 2004 including the lower Williamson and Sprague rivers, the Nine Mile area, and Beatty Gap. These areas may act as staging, resting, and/or spawning areas. Two temporally separated groups of LRS were detected entering the Chiloquin Dam fish ladder in 2004 (E. Janney, USGS, unpublished data). The temporal separation may indicate the presence of two distinct runs of LRS migrating into the Sprague River. Perkins et al. (2000) suggested the early spring run of LRS spawn in the upper Sprague River watershed while a later run of LRS spawn in the lower Sprague and Williamson rivers. Data collected on tagged LRS in 2004 lends support to this hypothesis. Of the eight LRS tagged from the first group of 57 LRS captured in the ladder prior to 5 April 2004, three were located near Kirk Spring in Beatty Gap. Another LRS appeared to have shed its tag in the Nine Mile area on its upstream migration and another was located near Lone Pine (rkm 55) presumably on its upstream migration and again in the western portion of the Upper Sprague River Valley (rkm 70) presumably on its downstream migration before it was last located in the Chiloquin Dam impoundment. Of the 12 LRS tagged after 5 April 2004, one was located in Beatty Gap, one was located near Kamkaun Spring, and eight appeared to have either remained in the lower reaches of the Williamson and Sprague rivers or migrated back to UKL.

A concurrent USGS study captured larval catostomids in the drift below Beatty Gap at the Godowa Springs Road Bridge and below the Ninemile area at the USFS Road 5810 (rkm 9.5) two to three weeks following the arrival of the tagged LRS to these areas (T. Tyler, USGS, unpublished data). Although spawning by LRS in these areas was not observed, the capture of larval catostomids in the drift suggests LRS spawning occurs upstream of these sample locations.

Similar to KLS, LRS appear capable of make rapid upstream and downstream migrations to and from presumed spawning areas. One LRS remained in the impoundment above Chiloquin Dam for at least ten days following its release. This fish was then located eight days later in Beatty Gap and was last contacted six days later in the Nine Mile area. Another LRS was contacted in Beatty Gap 16 days after release. This fish was next located in UKL 19 days later. These fish traveled distances of at least 201 and 247 rkm during 24 and 35 days, respectively. All of the LRS we located appeared to remain in the main stem of the lower Williamson and Sprague rivers and several were generally located near spring or groundwater influenced areas (i.e., Kirk Spring, Kamkaun Spring, and Beatty Gap).

Shortnose Sucker

The low number of SNS captured in the Chiloquin Dam fish ladder suggests they did not migrate above the dam in substantial numbers during 2004. Therefore, the movements of individuals tagged then released above the dam in 2004 may not be representative of SNS migrations in years when larger numbers of SNS migrate through the fish ladder.

Four of the nine SNS we tagged migrated upstream and were located between the impoundment and USFS Road 5810 bridge on the Sprague River. This suggests the reach between these points may contain suitable spawning habitat for SNS assuming that fish movement above the dam represents a spawning migration. It appears that SNS stayed in this reach of the river for approximately one week before presumably returning to UKL. The remaining five tagged SNS appear to have either dropped below the dam and returned to UKL after release or shed their tags in the impoundment above the dam.

Although data is limited, our observations corroborate those of Buettner and Scoppettone (1990) who reported that upstream migrations of SNS in the Williamson-Sprague watershed are considerably shorter than those of KLS or LRS. Bienz (C. Bienz, TNC, pers. comm.) found tagged SNS migrated only as far upstream as rkm 23 in the Sprague River. The furthest upstream location of the nine SNS tagged in 2004 was at rkm 10 on the Sprague River. The relatively short migration distances and short duration

that any of the nine tagged SNS in 2004 resided in the river suggests that SNS spawning may occur very quickly after passage at Chiloquin Dam.

Summary

Catostomids entering the Williamson and Sprague rivers migrated from UKL to discrete reaches of both rivers in spring 2004. Adult catostomid migrated to these locations in the watershed presumably to spawn. Migrations were typically rapid with arrival at and departure from upstream areas occurring in a matter of days, including river reaches over 100 rkm from UKL. In 2004, adult KLS tagged at the Chiloquin fish ladder were tracked to the Beatty Gap area on the Sprague River. Tagged SNS were tracked only into the lower reaches of the Sprague River between the impoundment and USFS Road 5810). Lost River suckers tagged at the fish ladder in 2004 demonstrated more variation than the other two species with individual LRS tracked to the Beatty Gap area, the Nine Mile area, and the lower Sprague River. Fish tagged and released above Chiloquin Dam were not located outside the mainstem Sprague River. Adult LRS and SNS entering the Williamson River from UKL were tracked into the lower Williamson River and the Sprague River below Chiloquin Dam. No fish radio-tagged and released below Chiloquin Dam were located above the dam.

Future efforts to monitor catostomid migrations in the Williamson-Sprague watershed will focus on improving the tag attachment technique, increasing contacts with fish, and providing for more on-the-ground detection time. Tag loss considerably reduced the number of study fish in 2004. An improved attachment location on the fish and more durable post and suture material will be used in future efforts. Increased contacts with tagged fish will provide better interpretation of data and allow a more accurate summary of migration in the watershed. In order to increase contacts with radio-tagged fish, we will use transmitters with increased battery life and signal strength and install remote receiving equipment at several locations throughout the watershed.

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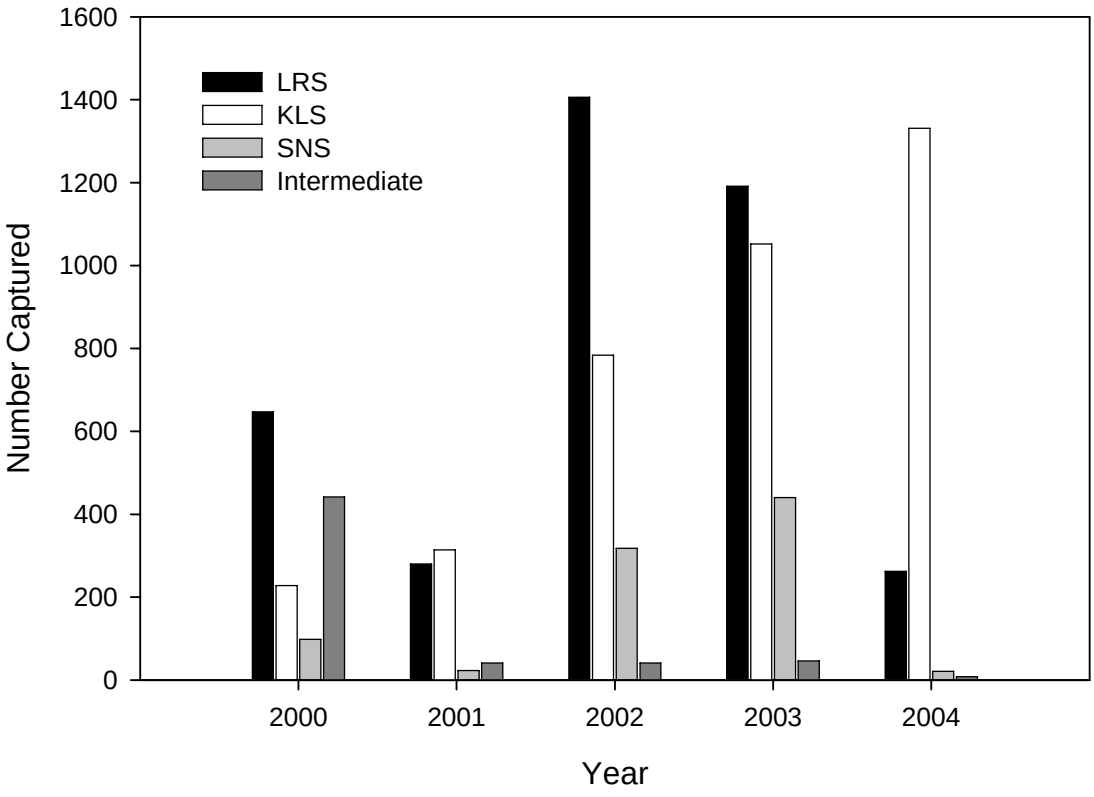

Figure 1. Number of Lost River suckers (LRS), shortnose suckers (SNS), Klamath largescale suckers (KLS), and suckers exhibiting intermediate morphological characteristics (Intermediate) captured in the Chiloquin Dam fish ladder during springtime sampling from 2000 through 2004 (E. Janney, USGS, unpublished data).

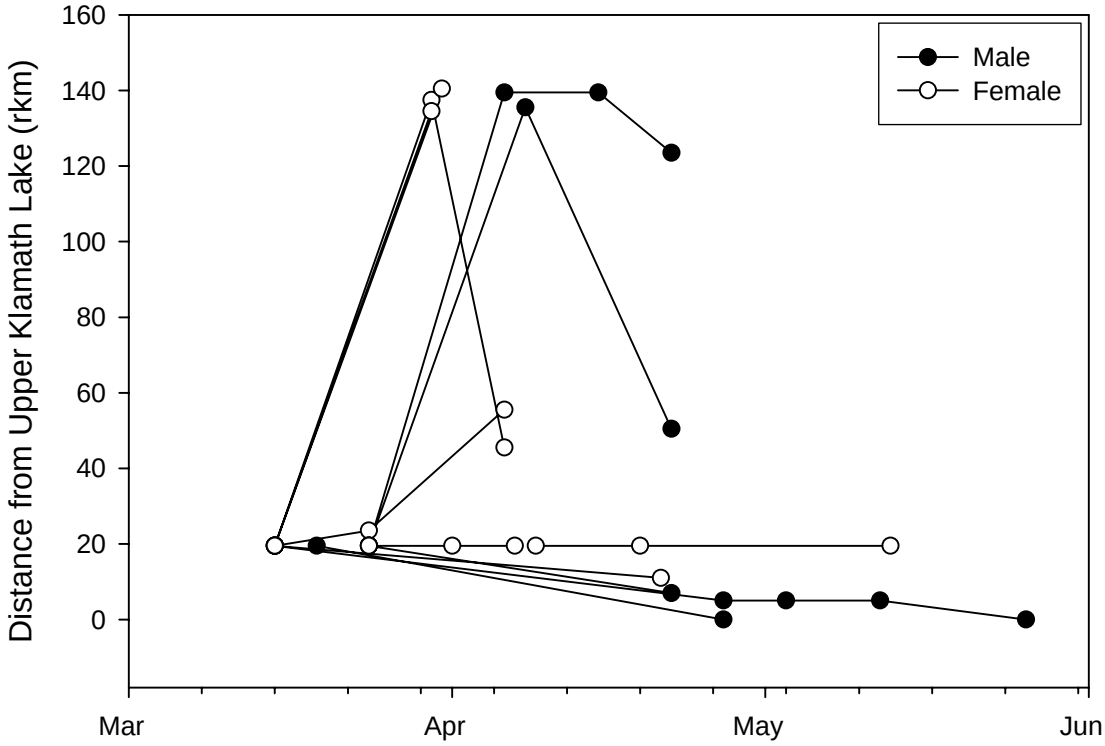

Figure 2. Distances from Upper Klamath Lake of migrating tagged Klamath largescale suckers in the lower Williamson and Sprague rivers in 2004.

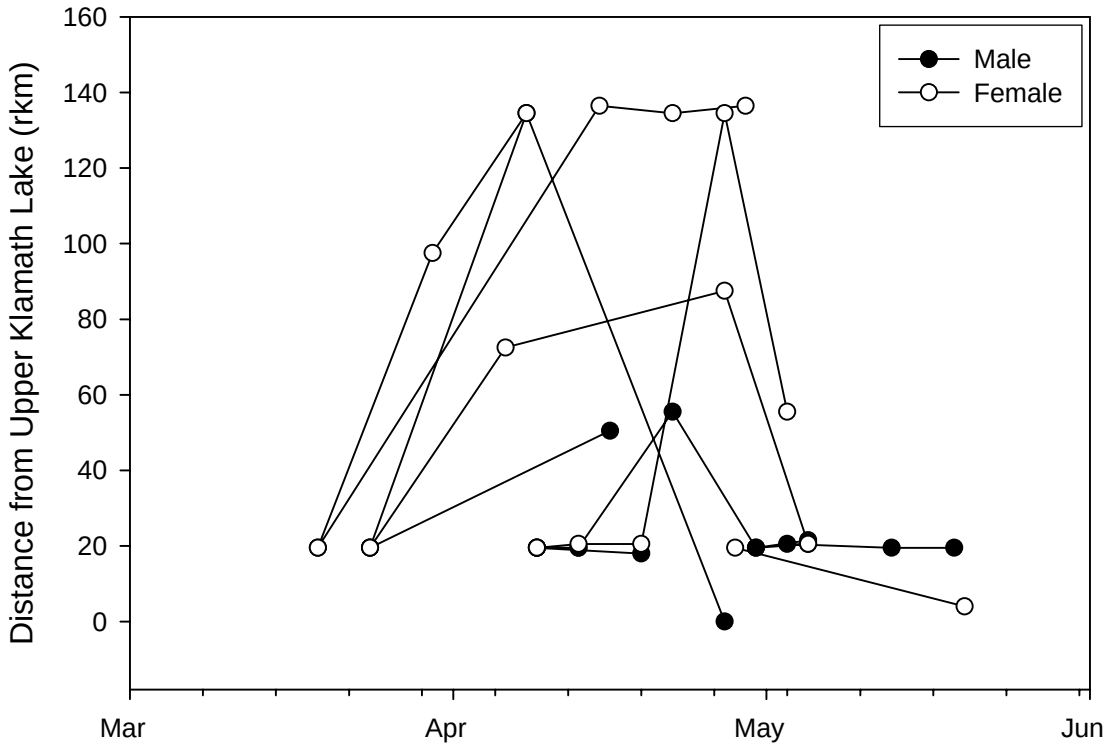

Figure 3. Distances from Upper Klamath Lake of migrating tagged Lost River suckers in the lower Williamson and Sprague rivers in 2004.

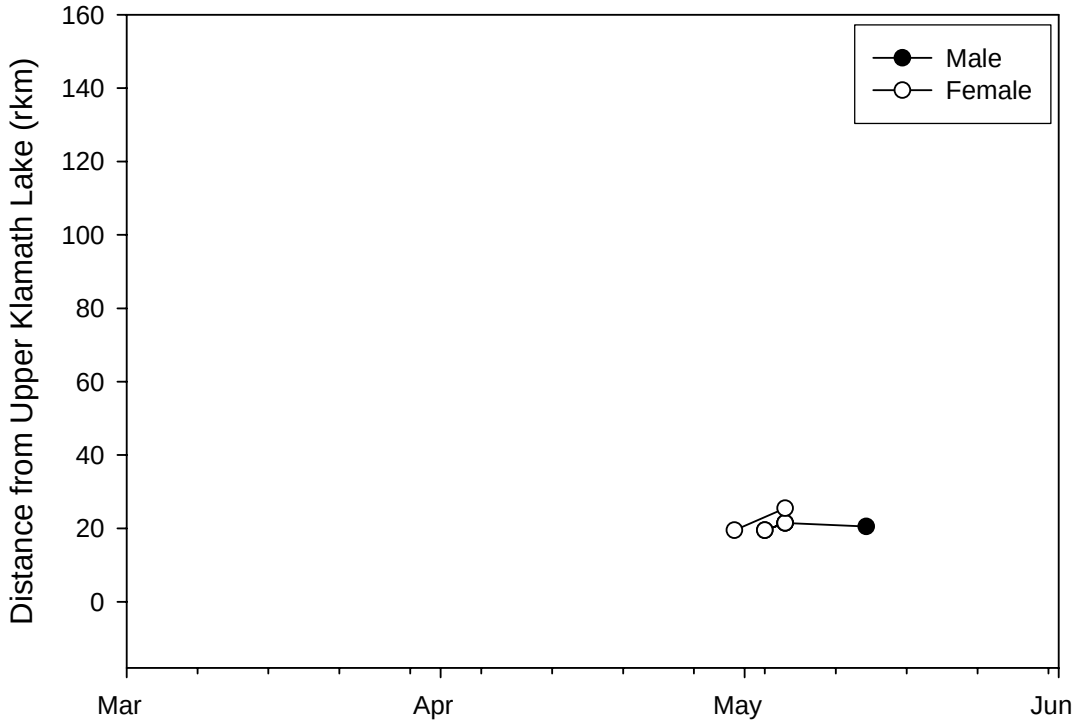

Figure 4. Distances from Upper Klamath Lake of migrating tagged shortnose suckers in the lower Williamson and Sprague rivers in 2004.

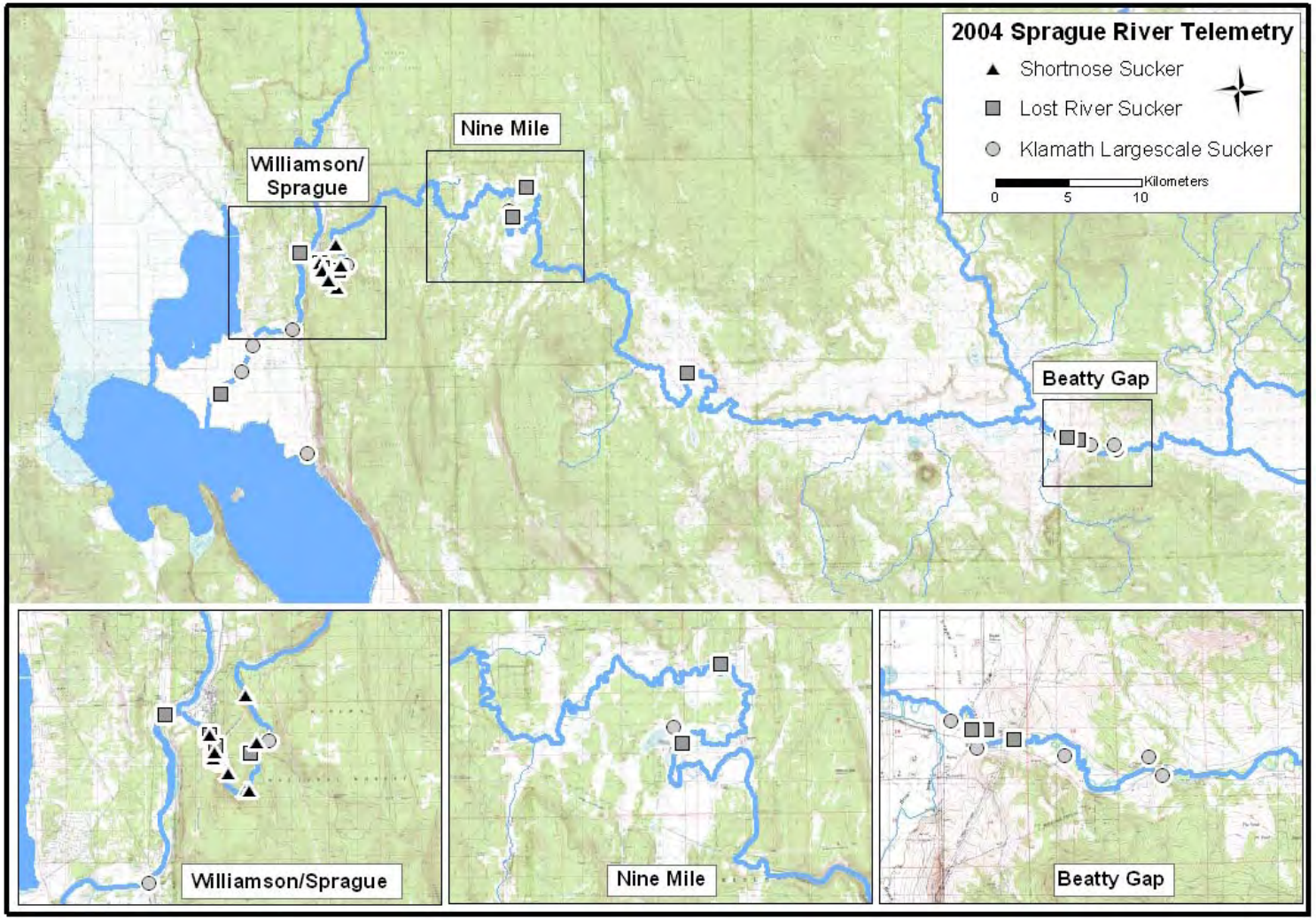

Figure 5. Locations of the furthest upstream contacts of radio-tagged Klamath largescale suckers, Lost River suckers, and shortnose suckers in the Sprague and Williamson rivers during spring, 2004.

Table 1. Contact dates and locations for adult Klamath largescale suckers radio-tagged at Chiloquin Dam in 2004. Fish locations are indicated as Sprague River river kilometer (rkm), Williamson River river kilometer (wrkm), or Upper Klamath Lake (ukl). Chiloquin Dam is located at rkm 1.3.

Fish	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11
KLS-1 Female	3/15/2004 (tagged)		4/1/2004 (rkm 4*)	4/7/2004 (rkm 4*)	4/13/2004 (rkm 4*)	4/19/2004 (rkm 4*)					
KLS-2 Female	3/15/2004 (tagged)	3/24/2004 (rkm 3*)	4/1/2004 (rkm 3*)	4/7/2004 (rkm 2*)	4/13/2004 (rkm 3*)	4/19/2004 (rkm 2*)	4/30/2004 (rkm 3*)				
KLS-3 Female	3/19/2004 (tagged)	3/24/2004 (rkm 2*)	4/1/2004 (rkm 2*)	4/7/2004 (rkm 2*)	4/13/2004 (rkm 2*)	4/19/2004 (rkm 2*)	4/30/2004 (rkm 2*)	5/5/2004 (rkm 2*)	5/13/2004 (rkm 2*)		
KLS-4 Male	3/15/2004 (tagged)	3/24/2004 (rkm 2*)	3/30/2004 (rkm 2*)	4/7/2004 (rkm 2*)	4/13/2004 (rkm 2*)	4/19/2004 (rkm 2*)	4/30/2004 (rkm 2*)		5/13/2004 (rkm 2*)		
KLS-5 Male	3/15/2004 (tagged)	3/24/2004 (rkm 2*)	4/1/2004 (rkm 2*)	4/7/2004 (rkm 2*)	4/13/2004 (rkm 2*)	4/19/2004 (rkm 2*)	4/30/2004 (rkm 2*)	5/5/2004 (rkm 2*)			
KLS-6 Male	3/19/2004 (tagged)	3/24/2004 (rkm 3*)	4/1/2004 (rkm 3*)	4/7/2004 (rkm 3*)	4/13/2004 (rkm 3*)	4/19/2004 (rkm 3*)	4/30/2004 (rkm 3*)	5/5/2004 (rkm 3*)	5/13/2004 (rkm 3*)		
KLS-7 Male	3/19/2004 (tagged)	3/24/2004 (rkm 2*)	4/1/2004 (rkm 2*)	4/7/2004 (rkm 2*)	4/13/2004 (rkm 2*)	4/19/2004 (rkm 2*)	4/30/2004 (rkm 2*)	5/5/2004 (rkm 2*)			
KLS-8 Male		3/24/2004 (tagged)		4/7/2004 (rkm 2*)		4/19/2004 (rkm 2*)	4/30/2004 (rkm 2*)	5/5/2004 (rkm 3*)	5/13/2004 (rkm 2*)	5/19/2004 (rkm 2*)	5/27/2004 (rkm 2*)
KLS-9 Female				4/9/2004 (tagged)	4/13/2004 (rkm 2*)	4/19/2004 (rkm 2*)	4/30/2004 (rkm 2*)	5/5/2004 (rkm 2*)	5/13/2004 (rkm 2*)	5/19/2004 (rkm 2*)	
KLS-10 Male	3/19/2004 (tagged)	3/24/2004 (rkm 2)									
KLS-11 Female	3/15/2004 (tagged)		3/30/2004 (rkm 117*)	4/6/2004 (rkm 117*)		4/22/2004 (rkm 117*)					
KLS-12 Female	3/15/2004 (tagged)		3/31/2004 (rkm 123*)	4/6/2004 (rkm 123*)	4/15/2004 (rkm 123*)	4/22/2004 (rkm 123*)					
KLS-13 Female	3/15/2004 (tagged)		3/30/2004 (rkm 120)	4/6/2004 (rkm 28)							
KLS-14 Male		3/24/2004 (tagged)		4/6/2004 (rkm 122)	4/15/2004 (rkm 122)	4/22/2004 (rkm 106)					
KLS-15 Female		3/24/2004 (tagged)		4/8/2004 (rkm 118)	4/16/2004 (rkm 33*)	4/22/2004 (rkm 33*)	4/27/2004 (rkm 33*)	5/5/2004 (rkm 33*)			
KLS-16 Female	3/15/2004 (tagged)	3/24/2004 (rkm 6)		4/6/2004 (rkm 38*)	4/16/2004 (rkm 38*)		4/27/2004 (rkm 38*)				

* Probable tag loss.

Table 1 (continued). Contact dates and locations for adult Klamath largescale suckers radio-tagged at Chiloquin Dam in 2004. Fish locations are indicated as Sprague River river kilometer (rkm), Williamson River river kilometer (wrkm), or Upper Klamath Lake (ukl). Chiloquin Dam is located at rkm 1.3.

Fish	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11
KLS-17 Female	3/15/2004 (tagged)		4/1/2004 (rkm 6*)	4/8/2004 (rkm 6*)	4/13/2004 (rkm 6*)	4/19/2004 (rkm 6*)					
KLS-18 Male	3/19/2004 (tagged)		4/1/2004 (rkm 6*)	4/8/2004 (rkm 6*)	4/13/2004 (rkm 6*)	4/19/2004 (rkm 6*)	4/29/2004 (rkm 6*)	5/5/2004 (rkm 6*)			
KLS-19 Female	3/15/2004 (tagged)					4/21/2004 (rkm 11*)	4/29/2004 (rkm 11*)	5/3/2004 (rkm 11*)	5/12/2004 (rkm 11*)		
KLS-20 Male	3/15/2004 (tagged)						4/27/2004 (rkm 5)	5/3/2004 (rkm 5)	5/12/2004 (rkm 5)		5/26/2004 (ukl)
KLS-21 Female		3/24/2004 (tagged)	4/1/2004 (rkm 2)	4/7/2004 (rkm 2)							
KLS-22 Male		3/24/2004 (tagged)				4/22/2004 (wrkm 7*)	4/27/2004 (wrkm 7*)	5/3/2004 (wrkm 7*)	5/12/2004 (wrkm 7*)		
KLS-23 Female				4/9/2004 (tagged)		4/19/2004 (rkm 2)			5/13/2004 (rkm 2*)	5/19/2004 (rkm 2*)	5/27/2004 (rkm 2*)
KLS-24 Male	3/19/2004 (tagged)						4/27/2004 (ukl)	5/3/2004 (ukl)			
KLS-25 Male	3/15/2004 (tagged)										

* Probable tag loss.

Table 2. Contact dates and locations for adult Lost River suckers radio-tagged at Chiloquin Dam in 2004. Fish locations are indicated as Sprague River river kilometer (rkm), Williamson River river kilometer (wrkm), or Upper Klamath Lake (ukl). Chiloquin Dam is located at rkm 1.3.

Fish	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11
LRS-1 Female	3/19/2004 (tagged)	3/24/2004 (rkm 2*)	4/1/2004 (rkm 2*)	4/7/2004 (rkm 2*)	4/13/2004 (rkm 2*)	4/19/2004 (rkm 2*)					
LRS-2 Female	3/19/2004 (tagged)	3/24/2004 (rkm 2*)	4/1/2004 (rkm 2*)	4/7/2004 (rkm 2*)	4/13/2004 (rkm 2*)	4/19/2004 (rkm 2*)	4/30/2004 (rkm 2*)	5/5/2004 (rkm 2*)			
LRS-3 Female		3/24/2004 (tagged)	4/1/2004 (rkm 2*)	4/7/2004 (rkm 2*)	4/13/2004 (rkm 2*)	4/19/2004 (rkm 2*)	4/30/2004 (rkm 2*)	5/5/2004 (rkm 3*)	5/13/2004 (rkm 2*)		
LRS-4 Male				4/9/2004 (tagged)	4/13/2004 (rkm 2*)	4/19/2004 (rkm 2*)	4/30/2004 (rkm 2*)		5/13/2004 (rkm 2*)	5/19/2004 (rkm 2*)	
LRS-5 Male								5/3/2004 (tagged)	5/13/2004 (rkm 2)	5/19/2004 (rkm 2)	
LRS-6 Female								5/7/2004 (tagged)	5/13/2004 (rkm 2*)	5/19/2004 (rkm 2*)	5/27/2004 (rkm 2*)
LRS-7 Female	3/19/2004 (tagged)		3/30/2004 (rkm 80)	4/8/2004 (rkm 117)		4/22/2004 (rkm 117)	4/29/2004 (rkm 117)				
LRS-8 Female	3/19/2004 (tagged)				4/15/2004 (rkm 119)	4/22/2004 (rkm 117)	4/29/2004 (rkm 119)				
LRS-9 Male		3/24/2004 (tagged)		4/8/2004 (rkm 117)			4/27/2004 (ukl)	5/3/2004 (ukl)	5/12/2004 (ukl)		
LRS-10 Female				4/9/2004 tagged)	4/13/2004 (rkm 3)	4/19/2004 (rkm 3)	4/27/2004 (rkm 117)	5/3/2004 (rkm 38)			
LRS-11 Female		3/24/2004 (tagged)		4/6/2004 (rkm 55)			4/27/2004 (rkm 70)	5/5/2004 (rkm 3)			
LRS-12 Male		3/24/2004 (tagged)			4/16/2004 (rkm 33*)	4/22/2004 (rkm 33*)	4/27/2004 (rkm 33*)	5/5/2004 (rkm 33*)		5/18/2004 (rkm 33*)	
LRS-13 Male				4/9/2004 (tagged)	4/13/2004 (rkm 2)	4/22/2004 (rkm 38)	4/30/2004 (rkm 2)	5/5/2004 (rkm 3)			
LRS-14 Male							4/30/2004 (tagged)	5/5/2004 (rkm 4)			
LRS-15 Female				4/9/2004 (tagged)				5/5/2004 (rkm 5*)	5/14/2004 (rkm 5*)	5/19/2004 (rkm 5*)	
LRS-16 Male				4/9/2004 (tagged)	4/13/2004 (rkm 2)						

* Probable tag loss.

Table 2 (continued). Contact dates and locations for adult Lost River suckers radio-tagged at Chiloquin Dam in 2004. Fish locations are indicated as Sprague River river kilometer (rkm), Williamson River river kilometer (wrkm), or Upper Klamath Lake (ukl). Chiloquin Dam is located at rkm 1.3.

Fish	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11
LRS-17 Male				4/9/2004 (tagged)		4/19/2004 (wrkm 18)					
LRS-18 Female							4/28/2004 (tagged)			5/20/2004 (wrkm 4)	
LRS-19 Female							4/28/2004 (tagged)				
LRS-20 Female								5/7/2004 (tagged)			

* Probable tag loss.

Table 3. Contact dates and locations for adult shortnose suckers radio-tagged at Chiloquin Dam in 2004. Fish locations are indicated as Sprague River river kilometer (rkm). Chiloquin Dam is located at rkm 1.3.

Fish	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11
SNS-1 Female							5/3/2004 (tagged)	5/5/2004 (rkm 4)			
SNS-2 Female							5/3/2004 (tagged)	5/5/2004 (rkm 4)			
SNS-3 Male								5/5/2004 (tagged)	5/13/2004 (rkm 3)		
SNS-4 Female							4/30/2004 (tagged)	5/5/2004 (rkm 8*)	5/14/2004 (rkm 8*)	5/19/2004 (rkm 8*)	
SNS-5 Female								5/5/2004 (tagged)	5/13/2004 (rkm 2)	5/19/2004 (rkm 2)	
SNS-6 Female							4/30/2004 (tagged)				
SNS-7 Female							4/30/2004 (tagged)				
SNS-8 Male								5/5/2004 (tagged)	5/13/2004 (rkm 2*)	5/19/2004 (rkm 2*)	5/27/2004 (rkm 2*)
SNS-9 Female							4/28/2004 (tagged)	5/5/2004 (rkm 3*)	5/13/2004 (rkm 3*)	5/19/2004 (rkm 3*)	5/27/2004 (rkm 3*)

* Probable tag loss.