Prepared in cooperation with the U.S. Fish and Wildlife Service

Assessing Movement and Sources of Mortality of Juvenile Catostomids Using Passive Integrated Transponder Tags, Upper Klamath Lake, Oregon—Summary of 2012 Effort

Open-File Report 2013–1062

U.S. Department of the Interior
U.S. Geological Survey

Assessing Movement and Sources of Mortality of Juvenile Catostomids Using Passive Integrated Transponder Tags, Upper Klamath Lake, Oregon—Summary of 2012 Effort

By Summer M. Burdick

Prepared in cooperation with the U.S. Fish and Wildlife Service

Open-File Report 2013-1062

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2013

Suggested citation:
Burdick, S.M, 2013, Assessing movement and sources of mortality of juvenile catostomids using passive integrated transponder tags, Upper Klamath Lake, Oregon—Summary of 2012 effort: U.S. Geological Survey Open-File Report 2013-1062, 12 p.

Contents

Figures

Tables

Conversion Factors, Datum, and Abbreviations and Acronyms

Conversion Factors

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	feet (ft)
kilometer (km)	0.6214	mile (mi)
	Frequency	
kilohertz (kHz)	1,000	cycles per second (cps)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8 \times °C) + 32.$$

Datum

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Abbreviations and Acronyms

Abbreviations	Meaning
PIT	passive integrated transponder
rkm	river kilometers

.

Assessing Movement and Sources of Mortality of Juvenile Catostomids Using Passive Integrated Transponder Tags, Upper Klamath Lake, Oregon—Summary of 2012 Effort

By Summer M. Burdick

Executive Summary

Survival of juvenile endangered Lost River and shortnose suckers is thought to limit recruitment into the adult populations and ultimately limit the recovery of these species in Upper Klamath Lake, Oregon. Although many hypotheses exist about the sources of mortality, the contribution of each speculated source of mortality has not been examined. To examine causes of mortality, validate estimated age to maturity, and examine movement patterns for juvenile suckers in Upper Klamath Lake, passive integrated transponder (PIT) tags and remote tag detection systems were used. Age-1 suckers were opportunistically tagged in 2009 and 2010 during another study on juvenile sucker distribution. After the distribution study concluded in 2010, USGS redirected sampling efforts to target age-1 suckers for tagging. Tags were redetected using an existing infrastructure of remote PIT tag readers and tag scanning surveys at American white pelican (*Pelecanus erythrorhynchos*), double-crested cormorant (*Phalacrocorax auritus*), and Forster's tern (*Sterna forsteri*) breeding and loafing areas. Individual fish histories are used to describe the distance, direction, and timing of juvenile sucker movement. Sucker PIT tag detections in the Sprague and Williamson Rivers in mid-summer and in autumn indicate tagged juvenile suckers use these tributaries outside of the known spring spawning season. PIT tags detected in bird habitats indicate predation by birds was a cause of mortality.

Introduction

Lost River suckers (*Deltistes luxatus*) and shortnose suckers (*Chasmistes brevirostris*) are both long-lived, late-maturing catostomids endemic to the Upper Klamath Basin in southern Oregon and northern California (Scoppettone and Vinyard, 1991). Both species were listed as endangered under the Endangered Species Act in 1988 (U.S. Fish and Wildlife Service, 1988). A persistent lack of recruitment of new individuals into adult spawning populations since the early 1990s led to population declines for both species (Janney and others, 2008, 2009; Hewitt and others, 2011). Rapidly decreasing catch rates of age-0 suckers each summer and extremely low catches of age-1 suckers, suggest survival of juvenile suckers is consistently low (Bottcher and Burdick, 2010). Little information exists on juvenile sucker movement and potential causes of mortality that could assist resource managers with recovery efforts.

A third Catostomidae that resides in the Upper Klamath Basin, the Klamath largescale sucker (*Catostomus snyderi*), is not protected under the Endangered Species Act. Presently, there is no non-lethal method to differentiate juvenile Klamath largescale, shortnose, and Lost River suckers; although genetic tests are being developed. The Klamath largescale sucker is the least studied of the Upper Klamath Basin suckers, so its population demography is poorly understood, especially during early life stages. The Klamath largescale sucker generally is considered a riverine species; although, individuals are occasionally captured in Upper Klamath Lake. Spawning migrations for this species occur about 1 month earlier than for Lost River and shortnose suckers, but genetic material is shared among the three species, suggesting some hybridization occurs or did occur in the recent past (Tranah and others, 2001).

Poor water quality, algal toxins, habitat alterations, interactions with exotic species, and avian predation (National Research Council, 2004; VanderKooi and others, 2010; Burdick, 2012a) have all been suggested as potential causes of high juvenile sucker mortality. Spatial-temporal patterns in catch rates indicate that the sudden onset of low-oxygen conditions in a western part of Upper Klamath Lake known as the trench may trap and kill juvenile suckers or preclude them from using productive deep water habitats each June (Bottcher and Burdick, 2010). In addition, *Microcystis aeruginosa* a hepatotoxin-producing cyanobacteria has been found in the gastrointestinal tracts of juvenile suckers exhibiting damaged liver tissue. This suggests a possible connection between the alga and sucker mortality (VanderKooi and others, 2010). Although a number of potential sources of juvenile sucker mortality have been identified, no attempts have been made to evaluate the relative importance of potential mortality sources. Movement out of a study area may be mistaken for mortality, and the causes or magnitude of mortality may be related to movement patterns of juvenile suckers. However, very little is known about the movement patterns of juvenile suckers.

Another area of uncertainty in juvenile sucker life history is the age of reproductive maturity. Age of reproductive maturity was previously estimated to be between 6 and 14 years based on annual marks formed in opercles (Buettner and Scoppettone, 1990). It was assumed that all marks present on opercles were annuli and that distance between marks decreased once fish spawned. Poor water quality and other environmental factors, however, can cause the formation of false annuli leading to uncertainty in age estimation, especially in older fish.

Passive integrated transponder (PIT) tag technology combined with active and passive tag detection systems allow us to examine the fate of tagged fish over a large geographic area. The use of this technology can provide data essential to understanding causes of juvenile sucker mortality and movement patterns, and the age at which suckers first spawn. Building on mark-recapture research of adult suckers in the Upper Klamath Basin that began in 1995, the U.S. Geological Survey (USGS) began PIT tagging age-1 suckers in 2009. Juvenile suckers were opportunistically tagged during a juvenile sucker habitat study project that captured suckers in 2009 and 2010. After that research project was discontinued, USGS redirected sampling efforts for the specific purpose of catching and tagging age-1 juvenile suckers. This report summarizes tagging effort and tag detections of juvenile suckers in 2012. A previous report covered tagging effort and tag redetections from 2009 to 2011 (Burdick, 2012a).

Methods

Fish Sampling

Age-1 and older juvenile suckers were captured using trap nets set overnight in Upper Klamath Lake, and the Williamson River Delta. Sample sites were selected using a random stratified approach as part of a study on juvenile sucker habitat use in 2009 and 2010. These sites were distributed throughout Upper Klamath Lake, and the Williamson River Delta in 2010 (Burdick, 2012b), and additionally throughout the southern two-thirds of Upper Klamath Lake in 2009 (Bottcher and Burdick, 2010; Burdick and Brown, 2010). To increase capture probability for age-1 or older juvenile suckers, sites were selected in 2011 and 2012 based on locations of above-average catches of age-1 suckers in a 2007 and 2008 study on juvenile sucker distribution (Burdick and others, 2009; Burdick and VanderKooi, 2010). In addition, we modified sampling locations throughout the 2011 field season to maximize our catch of age-1 and older suckers. In the 2012 field season, fish were sampled and tagged in three areas—Fish Banks, Tulana, and Goose Bay (fig. 1). The numbers of nets used to fish for juvenile suckers each year are given in table 1. Standard length (SL) was measured for all suckers captured. Because a non-lethal method of species identification has not been established for Klamath Basin suckers, a tissue sample was collected from each sucker in anticipation of the development of a genetic identification method.

Fish Tagging

Full duplex, 12.45 × 2.02 mm, 134.2 kHz, PIT tags were injected into the body cavity posterior to the pelvic girdle of healthy juvenile suckers 70 mm SL or longer and 8.00 × 2.02 mm PIT tags operating on the same frequency were injected into healthy juvenile suckers 60–70 mm SL. Mortality associated with the use of 12.45 mm PIT tags in juvenile suckers 72 mm SL or longer is less than 10 percent (Burdick, 2011). All suckers tagged in 2009 were at least 70 mm SL because the smaller 8.00 mm tags were not available for use in that year. Prior to tagging, suckers were scanned for the presence of a previously administered tag and anesthetized in a 0.02–0.03 mg/L solution of MS-222 prepared with lake water. Between each tag injection, needles were disinfected with a 3 percent chlorhexidine solution to reduce the probability of infection. Suckers were allowed to fully recover in a bucket of lake water before being released near the area of capture.

Redetection of Tagged Fish

Tags were reencountered when fish were recaptured in trap nets, detected on remote PIT tag antennas, or scanned on bird breeding or loafing areas. Remote detection systems and bird habitat scans were essential for reencountering tags, because physical recaptures were uncommon. From 2009 to 2012, USGS operated fixed passive detection systems, (1) in upstream and downstream traps of the Williamson River fish weir, (2) immediately upstream of the Williamson River fish weir, (3) immediately downstream of the former Chiloquin Dam site on the Sprague River, (4) 2.5 river km (rkm) upstream of the dam site, (5) 12 rkm upstream of the dam site (near Braymill), (6) at springs along the east shoreline of Upper Klamath Lake, and (7) in the Link River fish ladder on the Link River Dam. An additional remote detection system became operational March 8, 2012, in the lower Wood River (fig. 1). Remote detection systems were installed in March each year and removed in July 2009 and 2010 and in September 2011 and 2012. Remote detection systems read 12.45 mm PIT tags but do not reliably detect 8.00 mm PIT tags, which must be within about 10 cm of an antenna to be detected (B. Hayes, U.S. Geological Survey, oral commun., 2011). The largest American white pelican (*Pelecanus erythrorhynchos*) and double-crested cormorant (*Phalacrocorax auritus*) breeding colonies in the Upper Klamath National Wildlife Refuge were scanned in autumn 2009, 2010, and 2012 and at Clear Lake, California, from 2009 to 2012. American white pelican loafing sites and Forster's tern (*Sterna forsteri*) breeding sites in the Williamson River Delta restoration area and American white pelican loafing areas near the outlet of Upper Klamath Lake also were scanned for tags in October 2012.

Data were summarized to describe fishing effort, catch rates, number of tags given to fish, and number of tags detected. Individual histories are given for a few fish to illustrate the type of data collected. These histories provide limited information on the movement patterns of tagged suckers. Data collected so far are not sufficient to estimate or evaluate causes of mortality, or estimate age to maturity.

Data Summary and Discussion

Catch rates of age-1 and older suckers were higher when this age class was targeted compared to when a random stratified sampling approach was used. Catch rates in nets set between May 9 and June 22, a period of time that was sampled in all years, increased from 0.16 per net in 2009 and 0.03 per net set in 2010 to 0.43 in 2011 and 0.61 in 2012 (Bottcher and Burdick, 2010; Burdick and Brown, 2010; Burdick, 2012b). In 2009 and 2010, nets were spread throughout the study area. In contrast, 2011 and 2012 sample sites primarily were located in water less than 1 m deep in the Goose Bay part of the Williamson River Delta, where annual average catch rates were 0.58 suckers per net in 2011 and 0.48 suckers per net in 2012.

More age-1 suckers shorter than 70 mm SL were captured in spring 2011 than in 2010 or 2012. This resulted in 8.00 mm tags making up 44 percent of tags in 2011 compared to only 15 percent in 2010 and 4 percent in 2012 (table 1). A total of five fish were redetected in 2012; two tagged in 2011 and three tagged in 2012 (table 2). Nearly all redetected tags in all years were 12.45 mm long. A single 8.00 mm tag was redetected the Williamson River weir array in 2012.

From 2009 to 2012 a total of 16 individual juvenile suckers 72 to 212 mm SL were detected in the Williamson and Sprague Rivers (table 3). Of these, three were detected in multiple years. Most juvenile sucker detections in the rivers occurred at the Williamson River weir between May and August (table 3). Only one tagged juvenile sucker was detected in the river during the spawning season. This sucker was tagged at 97 mm SL in the Williamson River Delta in May 2009 and detected on March 17, 2010, at the Williamson River weir (table 3). Four juvenile suckers were detected upstream of the Williamson River weir on at least one occasion (fig. 2). The farthest upstream juvenile sucker detections occurred between July 9 and July 11, 2012, at Braymill (rkm 31) for a 212 mm SL sucker.

Data collected in this study provides some of the first evidence that juvenile suckers migrate upstream of Upper Klamath Lake into the Williamson and Sprague Rivers during summer months. Similarly, 14 tagged age-0 and age-1 suckers salvaged from A and J canals and released into the southern end of Upper Klamath Lake were detected at the Williamson River weir in 2011 (A. Wilken, Bureau of Reclamation, oral commun., 2012). Although in-river detections represent a large portion of juvenile suckers redetected, they do not necessarily indicate that a large portion of juvenile suckers migrate into the Williamson and Sprague Rivers in the summer. A high number of detections in the rivers compared to the bird colonies or physical recaptured fish is likely due to the higher efficacy of our remote sampling gear relative to the methods used to redetect tags in other areas. Tag detections may indicate the presence of predators, such as Klamath redband trout (*Oncorhynchus mykiss* subsp.) that ate tagged suckers, rather than suckers. Because some tags were detected over several months, and stomach evacuation of trout is unlikely to take that long, it was assumed that detected tags were in live suckers. Another possibility is that the fish detected on river antennas were the more riverine Klamath largescale sucker rather than one of the two endangered suckers. The remaining explanation for these detections is that they are indications of juvenile endangered sucker species moving into the rivers during the summer months.

Tag detections on bird colonies indicate predation was the cause of mortality for at least seven (4.1 percent) suckers tagged in 2009, two (4.7 percent) suckers tagged in 2010, two (1.2 percent) suckers tagged in 2011, and six (2.8 percent) tagged in 2012. Tags injected into these fish were detected on American white pelican or double-crested cormorant breeding or loafing areas in the Upper Klamath National Wildlife Refuge. Tags were not detected in habitat dominated by loafing or breeding Forster's terns. Because both American white pelicans and double-crested cormorants primarily feed on live fish (Derby and Lovvorn, 1997), it can be assumed that these fish were eaten alive and did not die of other causes. The rate of redetected tags on bird colonies is certainly an underestimate of the portion of juvenile suckers eaten by birds, due to an inability to scan off-colony tag deposition and incomplete detection of on-colony tag deposition. High rates of infection and parasites on juvenile suckers in Upper Klamath Lake may make juvenile suckers more susceptible to avian predation by reducing their swimming ability (Foott, 2004; Bottcher and Burdick, 2010; Iwanowicz, 2011). Periodic anoxic conditions in Upper Klamath Lake also may elevate avian predation by forcing juvenile suckers to surface and gulp air (Foott and others, 2007).

This study was limited by the number of suckers captured that were of a tagable size and by a low redetection rate. Although the efficiency of catching juvenile suckers increased between 2010 and 2011, an even greater number of juvenile suckers will need to be tagged and redetected to estimate survival. As a general rule, to estimate demographic parameters from tagging studies approximately 20 percent of the tags need to be redetected (Hewitt and others, 2010). Our 4- year redetection rate was 6.7 percent. The low tag redetection rate may be due to the large area in which tagged suckers can be distributed (the area of Upper Klamath Lake is approximately 280 km^2; Johnson, 2012), and the location of remote detection systems. Remote detection systems were placed so they would intercept fish as they migrated to spawning grounds. This placement is not optimal for our purposes because we do not expect the age-1 suckers tagged in this study to make spring migrations to spawning grounds within a year or two of tagging. It is not clear, however, where to place remote detection systems to increase detections of juvenile suckers, because these fish do not appear to concentrate into a small enough area to be targeted by remote detection systems.

The success of this project for studying movement and age to maturity depends on a large number of suckers being produced and surviving to age-1, tagging a significant portion of that age group, and successful redetection. Yearly production of juvenile suckers, however, is extremely variable and was not high in any years of the study. Therefore, catch rates of juvenile suckers were low and we were only able to tag 592 suckers over 4 years. Increased effort to detect tags on bird loafing and breeding area in 2012 failed to locate a large numbers of tags. Without of a large production event, we can expect continued years of effort to make small but steady annual improvements in the total number of tags distributed and redetected. With these data, age to maturity may be determined over time. Our ability to study movement is limited because tag detections occurred in a limited number of areas on remote systems or at bird colonies.

Acknowledgments

Data were collected in 2012 with the help of Travis Ciotti (USGS) and Elizabeth Ng (USGS). Alta Harris (USGS) and Amari Dolan-Caret (USGS) developed and manage the database used in this research. The Nature Conservancy allowed access to the land on which much of this study was conducted. This work was funded by the U.S. Fish and Wildlife Service and the U.S. Geological Survey.

References Cited

Bottcher, J., and Burdick, S.M., 2010, Temporal and spatial distribution of endangered juvenile Lost River and shortnose suckers in relation to environmental variables in Upper Klamath Lake, Oregon—2009 annual data summary: U.S. Geological Survey Open-File Report 2010-1261, 42 p. (Also available at *http://pubs.usgs.gov/of/2010/1261/*.)

Buettner, M., and Scoppettone, G.G., 1990, Life history and status of Catostomids in Upper Klamath Lake, Oregon: Reno, Nevada, Oregon Department of Fish and Wildlife, Klamath Tribe, and National Fisheries Research Center, 119 p.

Burdick, S.M., 2011, Tag loss and short-term mortality associated with passive integrated transponder (PIT) tagging of juvenile Lost River suckers: North American Journal of Fisheries Management, v. 31, p. 1088–1092.

Burdick, S.M., 2012a, Tagging age-1 Lost River and shortnose suckers with passive integrated transponders, Upper Klamath Lake, Oregon–Summary of 2009–11 effort: U.S. Geological Survey Open-File Report 2012–1076, 10 p. (Also available at *http://pubs.usgs.gov/of/2012/1076/*.)

Burdick, S.M., 2012b, Distribution and condition of larval and juvenile Lost River and shortnose suckers in the Williamson River Delta restoration project and Upper Klamath Lake, Oregon—2010 annual data summary: U.S. Geological Survey Open-File Report 2012-1027, 39 p. (Also available at *http://pubs.usgs.gov/of/2012/1027/*.)

Burdick, S.M., and Brown, D.T., 2010, Distribution and condition of larval and juvenile Lost River and shortnose suckers in the Williamson River Delta restoration project and Upper Klamath Lake, Oregon—2009 annual data summary: U.S. Geological Survey Open-File Report 2010-1216, 78 p. (Also available at *http://pubs.usgs.gov/of/2010/1216/*.)

Burdick, S.M., and VanderKooi, S.P., 2010, Temporal and spatial distribution of endangered juvenile Lost River and shortnose suckers in relation to environmental variables in Upper

Klamath Lake, Oregon—2008 annual data summary: U.S. Geological Survey Open-File Report 2010-1051, 46 p. (Also available at *http://pubs.usgs.gov/of/2010/1051/*.)

Burdick, S.M., VanderKooi, S.P., and Anderson, G.O., 2009, Spring and summer spatial distribution of endangered juvenile Lost River and shortnose suckers in relation to environmental variables in Upper Klamath Lake, Oregon—2007 annual report: U.S. Geological Survey Open-File Report 2009-1043, 56 p. (Also available at *http://pubs.usgs.gov/of/2009/1043/*.)

Derby, C.E., and Lovvorn, J.R., 1997, Predation on fish by cormorants and pelicans in a cold-water river—a field and modeling study: Canadian Journal of Fisheries and Aquatic Science, v. 54, p. 1480–1493.

Foott J.S., 2004, Health monitoring of adult Lost River Sucker (*Deltistes luxatus*) and shortnose sucker (*Chasmistes brevirostris*) in upper Klamath Lake, Oregon, April–September 2003: U.S. Fish and Wildlife Service, 37 p. (Also available at *http://www.fws.gov/canvfhc/reports*)

Foott, J.S., Stone, R., and Fogerty, R., 2007, Lack of disease response in juvenile Upper Klamath Lake suckers (age-0+) to adverse water quality conditions–pilot study August 2007: U.S. Fish and Wildlife Service Report, 12 p.

Hewitt, D.A., Hayes, B.S., Janney, E.C., Harris, A.C., Koller, J.P., and Johnson, M.A., 2011, Demographics and run timing of adult Lost River (*Deltistes luxatus*) and shortnose (*Chasmistes brevirostris*) suckers in Upper Klamath Lake, Oregon, 2009: U.S. Geological Survey Open-File Report 2011-1088, 43 p. (Also available at http://pubs.usgs.gov/of/2011/1088/.)

Hewitt, D.A., Janney, E.C., Hayes, B.S., and Shively, R.S., 2010, Improving inferences from fisheries capture-recapture studies through remote detection of PIT tags: Fisheries, v. 35, no. 5, p. 217–231.

Iwanowicz, D.D., 2011, Overview of the effects of parasites on fish health, Proceeding of: Bridging America and Russia with Shared Perspectives on Aquatic Animal Health, Third Bilateral Conference between Russia and the United States, at Shepherdstown, West Virginia, v. 3.

Janney, E.C., Hayes, B.C., Hewitt, D.A., Barry, P.M., Scott, A.C., Koller, J.P., Johnson, M.A., and Blackwood, G., 2009, Demographics and 2008 run timing of adult Lost River (*Deltistes luxatus*) and shortnose (*Chasmistes brevirostris*) suckers in Upper Klamath Lake, Oregon, 2008: U.S. Geological Survey Open-File Report 2009-1183, 32 p. (Also available at http://pubs.usgs.gov/of/2009/1183/.)

Janney, E.C., Shivley, R.S., Hayes, B.S., and Barry, P.M., 2008, Demographic analysis of Lost River sucker and shortnose sucker populations in Upper Klamath Lake, Oregon: Transactions of the American Fisheries Society, v. 137, p. 1812–1825.

Johnson, D.M., 2012, Atlas of Oregon Lakes: Portland Oregon, Portland State University Press, accessed February 25, 2012, at *http://www.aol.research.pdx.edu/*.

National Research Council, 2004, Endangered and threatened fishes in the Klamath River Basin—Causes of decline and strategies for recovery: Washington, D.C., The National Academies Press, 398 p.

Scoppettone, G.G., and Vinyard, G., 1991, Life history and management of four endangered lacustrine suckers, *in* Minckley, W.L., and Deacon, J.E., eds., Battle against extinction—Native fish management in the American West: Tucson, The University of Arizona Press, p. 359-377.

Tranah, G.J., Agresti, J.J., and May, B., 2001, New microsatellite loci for suckers (Catostomidae): primer homology in *Catostomus*, *Chasmistes*, and *Deltistes:* Molecular Ecology Notes, v. 1, p. 55–60.

U.S. Fish and Wildlife Service, 1988, Endangered and threatened wildlife and plants—Determination of endangered status for the shortnose sucker and Lost River sucker: Federal Register, v. 53, p. 27,130–27,134.

VanderKooi, S.P., Burdick, S.M., Echols, K.R., Ottinger, C.A., Rosen, B.H., and Wood, T.M., 2010, Algal toxins in Upper Klamath Lake, Oregon—Linking water quality to juvenile sucker health: U.S. Geological Survey Fact Sheet 2009-3111, 2 p. (Also available at http://pubs.usgs.gov/fs/2009/3111/.)

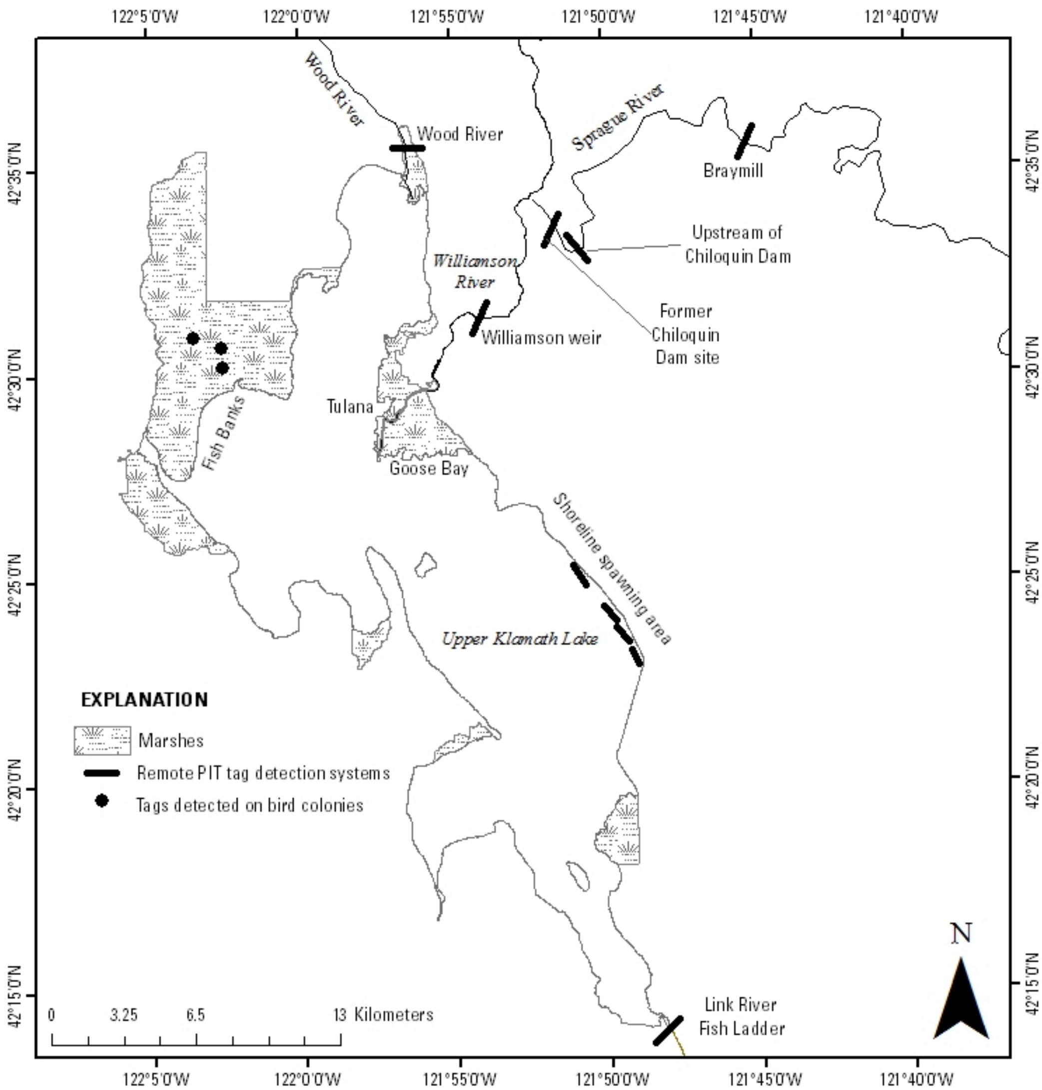

Figure 1. Map of Upper Klamath Lake, Oregon, including locations of remote PIT tag detection systems and sites where tags were detected on bird colonies. All remote detection systems were active from 2009 to 2011, except the Wood River system, which was activated March 8, 2012.

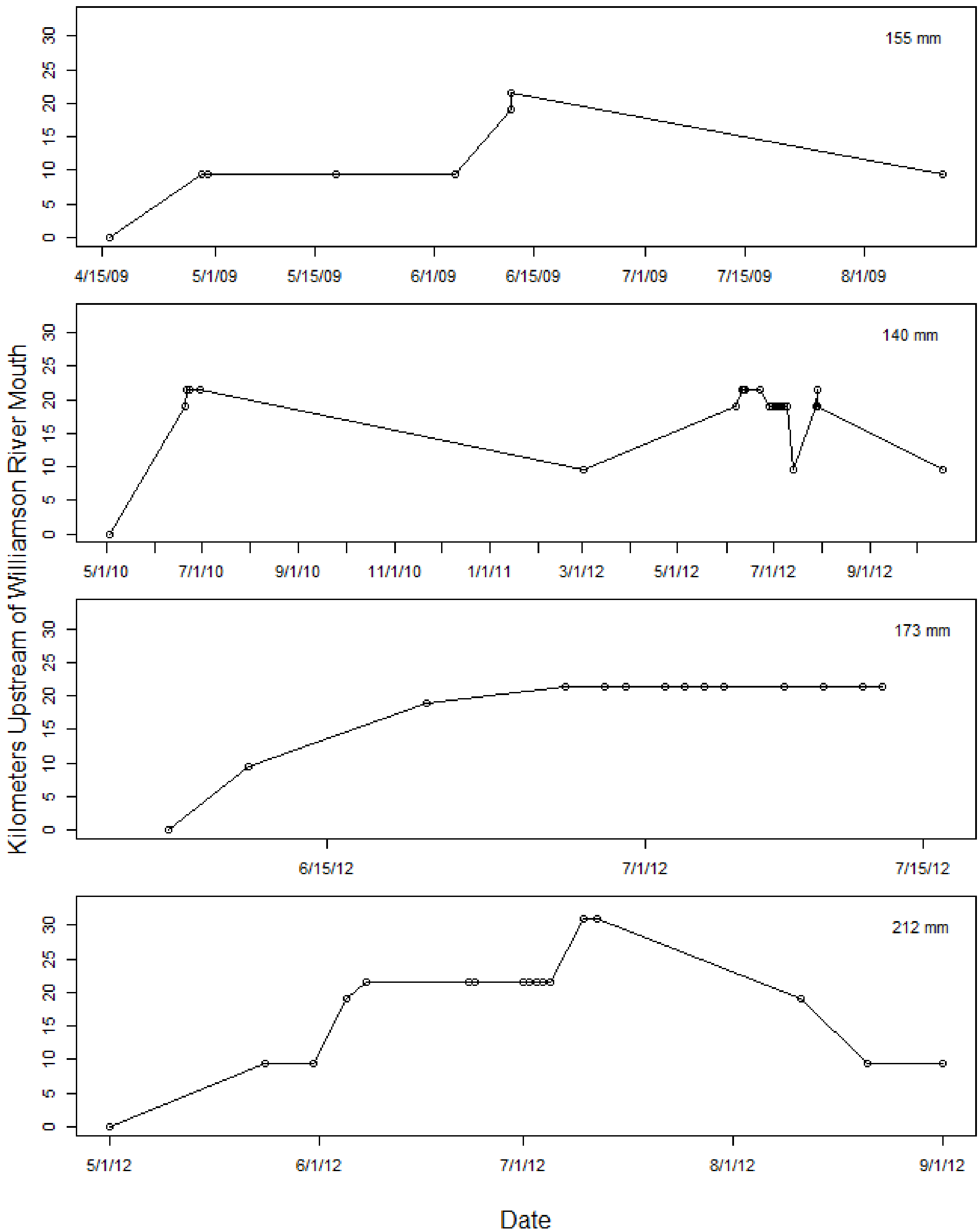

Figure 2. Movement of four juvenile suckers detected upstream of the Williamson River weir on remote antenna arrays in the Williamson or Sprague Rivers, Oregon. All suckers were tagged in the Williamson River Delta, which was considered 0 rkm upstream of Williamson River mouth. Detection systems also were present at 9.5 rkm (Williamson River weir), 19 rkm (Chiloquin Dam site), 21.5 rkm (upstream of the Chiloquin Dam site), and 31 rkm (Braymill). The standard length of each fish at the time of tagging is given.

Table 1. Number of trap nets fished before July 1 in each year, number of suckers less than 350 mm standard length given 8.00 mm and 12.45 mm PIT tags, and number of PIT tags redetected on remote sensing equipment or physically recaptured by year, Upper Klamath Lake, Oregon, 2009–12.

[N/A, not applicable]

	Year			
	2009	2010	2011	2012
Number of nets fished	1,443	1,099	488	347
Tagged with 8.00 mm	0	6	72	7
Tagged with 12.45 mm	170	37	93	207
Detected on remote antennas	8	6	5	5
Recaptured in juvenile sampling	0	0	3	0
Detected on bird colonies	6	3	N/A	8

Table 2. Number of age-1 suckers tagged with either 8.00 mm or 12.45 mm PIT tags and redetected or recaptured each year, Upper Klamath Lake or adjacent marshes, Oregon, 2009–12.

		Year redetected			
Year tagged	Number tagged	2009	2010	2011	2012
2009	170	14	5	2	0
2010	43		4	1	0
2011	165			5	4
2012	214				9

Table 3. Dates that juvenile suckers were detected at the Williamson River weir.

[The weir is located 9.5 km upstream of the mouth of the Williamson River. Each detection event is given on a separate line. Detection events within the same year were distinguished by a detection of the same fish at a different location. Lines highlighted in grey are the same fish on different occasions. Standard length of each fish at the time of tagging is given]

	Detected at weir		
Date tagged	First	Last	Standard length (mm)
5-20-09	7-8-09	7-8-09	72
4-16-09	4-29-09	6-4-09	155
4-16-09	8-12-09	8-12-09	155
5-18-09	5-26-09	7-16-09	98
5-17-09	11-12-10	11-12-10	131
6-3-09	6-9-09	6-9-09	169
5-3-10	5-2-11	5-2-11	140
5-3-10	7-14-11	7-14-11	140
5-3-10	10-17-11	10-17-11	140
5-19-09	5-15-10	5-28-10	208
5-4-09	6-7-09	6-7-09	112
5-28-09	6-4-09	7-30-09	97
5-11-09	6-5-09	8-30-09	97
5-11-09	3-17-10	3-17-10	97
6-3-09	8-5-09	8-6-09	80
6-21-11	5-30-12	5-30-12	64
6-14-11	6-21-11	8-27-11	145
6-14-11	5-2-12	9-15-12	145
5-25-11	5-24-11	24-Jul-11	140
6-6-12	6-10-12	10-Jun-12	173
4-30-12	5-23-12	30-May-12	212
4-30-12	8-20-12	31-Aug-12	212
6-6-12	6-12-12	12-Jun-12	105

Publishing support provided by the U.S. Geological Survey
Publishing Network, Tacoma Publishing Service Center

For more information concerning the research in this report, contact the
Director, Western Fisheries Research Center
U.S. Geological Survey
6505 NE 65th Street
Seattle, WA 98115
http://wfrc.usgs.gov/

Burdick—**Assessing Movement and Sources of Mortality of Juvenile Catostomids Using Passive Integrated Transponder Tags, Upper Klamath Lake, Oregon—Summary of 2012 Effort**—Open-File Report 2013–1062