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

Tagging Age-1 Catostomids with Passive Integrated Transponder Tags, Upper Klamath Lake, Oregon—Summary of 2009–11 Effort

Open-File Report 2012–1076

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

Tagging Age-1 Catostomids with Passive Integrated Transponder Tags, Upper Klamath Lake, Oregon—Summary of 2009–11 Effort

By Summer M. Burdick

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

Open-File Report 2012-1076

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

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

U.S. Geological Survey
Marcia K. McNutt, Director

U.S. Geological Survey, Reston, Virginia: 2012

For more information on the USGS—the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment, visit *http://www.usgs.gov* or call 1-888-ASK-USGS.

For an overview of USGS information products, including maps, imagery, and publications, visit *http://www.usgs.gov/pubprod*

To order this and other USGS information products, visit *http://store.usgs.gov*

Suggested citation:
Burdick, S.M., 2012, 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.

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Although this report is in the public domain, permission must be secured from the individual copyright owners to reproduce any copyrighted material contained within this report.

Contents

Executive Summary 1
Introduction 1
Methods 2
Data Summary 4
Discussion 5
Acknowledgments 6
References Cited 6

Figure

Figure 1. Map of study area, including sites fished for age-1 suckers in 2011, and locations of remote PIT tag detection systems 8

Tables

Table 1. Number of trap nets fished between May 9 and June 22, number of age-1 suckers given 8 mm and 12 mm PIT tags, and number of PIT tags redetected on remote sensing equipment or physically recaptured by year, Upper Klamath and Agency Lakes, Oregon, 2009–11. 9
Table 2. Number and location of trap nets set and catch rates for age-1 suckers by sampling area in Upper Klamath Lake, Oregon, 2011. 9
Table 3. Number of age-1 suckers tagged and redetected or recaptured each year, Upper Klamath Lake, Oregon, 2009–11. 10

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)	1.66×10^{-5}	rounds per minute (rpm)

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

°F=(1.8×°C)+32.

Datum

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

Tagging Age-1 Catostomids with Passive Integrated Transponder Tags, Upper Klamath Lake, Oregon—Summary of 2009–11 Effort

By Summer M. Burdick

Executive Summary

A passive integrated transponder (PIT) tagging study was initiated in 2009 for age-1 endangered Lost River and shortnose suckers in Upper Klamath Lake, Oregon, for the purpose of examining causes of mortality, validating estimated age to maturity, and examining movement patterns. This study, which was done opportunistically in 2009 and 2010, received funding in 2011 for a directed tagging effort. Tags were redetected using an existing infrastructure of remote PIT tag readers and tag scanning surveys at American white pelican and double-crested cormorant breeding and loafing areas. Individual fish histories are used to describe the distance, direction, and timing of age-1 sucker movement. Sucker PIT tag detections in the Sprague and Williamson rivers in mid-summer and in autumn indicate age-1 suckers use these tributaries outside of the known spring spawning season. PIT tags detected in bird habitats indicate predation by birds may have been a cause of mortality in 2009. Field conditions prevented scanning bird breeding and loafing areas in Upper Klamath Wildlife National Refuge for tags in 2011, however, limiting our ability to make inferences about bird predation in those years.

Introduction

The Lost River sucker (*Deltistes luxatus*) and shortnose sucker (*Chasmistes brevirostris*) are both long-lived, late-maturing catastomids endemic to the Upper Klamath Basin in southern Oregon and northern California (Scoppettone and Vinyard, 1991). Both were listed as endangered under the Endangered Species Act in 1988 (National Research Council, 2004). Lack of recruitment into adult spawning populations threatens the recovery of both species (Janney and others, 2008, 2009; Hewitt and others, 2011). Rapidly decreasing catch rates of age-1 suckers between May and July and low overall catches of suckers in the age-1 class, suggest that limiting factors in survival of age-1 suckers consistently occur during the first several years of life in Upper Klamath Lake (Bottcher and Burdick, 2010). A limited amount of available information on movement, habitat use, and the causes of mortality for juvenile suckers exist to assist with recovery planning.

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. The Klamath largescale sucker is the least studied of the Upper Klamath Basin suckers,

so its population demography especially during early life stages is poorly understood. 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 predation by birds (National Research Council, 2004; A. Evans, Real Time Research, written commun., 2009; VanderKooi and others, 2010) have all been suggested as causes of high juvenile sucker mortality. Spatial-temporal patterns in catch rates indicate low dissolved-oxygen concentrations in parts of Upper Klamath Lake preclude age-1 suckers from using some habitats and may be related to high apparent mortality (Bottcher and Burdick, 2010). *Microcystis aeruginosa*, a hepatotoxin-producing cyanobacteria, found in the guts of juvenile suckers with damaged liver tissue from Upper Klamath Lake, indicates a possible connection between the alga and sucker mortality (VanderKooi and others, 2010).

Although there are many potential causes of juvenile sucker mortality, no attempts have been made to rank the relative importance of these potential causes or estimate mortality rates for juvenile suckers. Capture-recapture methods and passive integrated transponder (PIT) tags offer a robust approach to examining the causes of age-1 sucker mortality. PIT tags can be detected remotely and mortality associated with their use in juvenile suckers 61 mm or longer is less than 10 percent (Burdick, 2011). 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. This report summarizes tagging effort and tag detections of age-1 suckers from 2009 to 2011.

Methods

Age-1 and older juvenile Lost River and shortnose suckers were sampled using trap nets set overnight in Upper Klamath Lake, Agency Lake, and the Williamson River Delta. The restoration of the Williamson River Delta from 2007 to 2008 connected Upper Klamath and Agency lakes, and some consider this single water body Upper Klamath Lake. In this report, however, we continue to call these areas by their historic names, because that is how they are known by local biologists and managers. Sample sites were selected in 2009 and 2010 using a random stratified approach, and were distributed throughout Upper Klamath Lake, the southern one-third of Agency Lake, and the Williamson River Delta in 2010 (Burdick, 2012), 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 suckers, sites were selected in 2011 based on above-average catches of age-1 suckers in 2007 and 2008 sampling (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 suckers. The numbers of nets used to fish for age-1 suckers during the same spring 6-week period (May 9–June 22) each year are given in table 1. Standard length (SL) was measured, and the presence of deformities and macroparasites were noted 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.

Full duplex, 12.45 × 2.02 mm, 134.2 kHz, PIT tags were injected into 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. 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.

Tags were redetected when fish were physically recaptured, or detected by remote PIT tag antennas or on bird breeding or loafing areas. Remote detection systems and bird habitat scans were essential for redetecting tags, because physical recaptures were difficult to obtain. USGS operates fixed passive detection systems in upstream and downstream traps of the Williamson River fish weir, immediately upstream of the Williamson River fish weir, immediately downstream of the former Chiloquin Dam site on the Sprague River, 2.5 river km upstream of the dam site, 9.2 river km upstream of the dam site (near Braymill), at springs along the east shoreline of Upper Klamath Lake, and in the Link River fish ladder on the Link River Dam (fig. 1). An additional remote tag detection system located in the lower Wood River will be operational in spring 2012. Remote detection systems read 12 mm PIT tags but do not reliably detect 8 mm PIT tags, given they 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 October 2009 and September 2010 and at Clear Lake, California, from 2009 to 2011 by a private consulting firm, Real Time Research, who shared tag detection data. Bird breeding colonies in the Upper Klamath National Wildlife Refuge were not scanned for tags in 2011 due to difficulties with access.

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. Data collected so far are not sufficient to estimate or evaluate causes of mortality.

Data Summary

Catch rates were higher when age-1 suckers were targeted compared to when a random stratified sampling approach was used. Catch rates in nets set between May 9 and June 22 increased from 0.16 per net in 2009 and 0.03 per net set in 2010 to 0.43 in 2011 (Bottcher and Burdick, 2010; Burdick and Brown, 2010; Burdick, 2012). In 2009 and 2010, nets were spread throughout the study area. In contrast, 2011 sample sites primarily were located in water less than 1 m deep in the Goose Bay part of the Williamson River Delta, where three age-1 suckers were caught for every four nets set. Fewer nets were set in the Tulana part of the Williamson River Delta and at Hagelstein Park, where catch rates were less than 0.1 age-1 suckers per net. When no age-1 suckers were captured in several fishing attempts within an area, such as in Howard and Shoalwater bays, sampling was not repeated there (table 2), which also increased overall capture success in 2011.

More age-1 suckers less than 70 mm SL were captured in spring 2011 than in the previous 2 years. This resulted in 8 mm tags making up 44 percent of tags in 2011 compared to only 15 percent in 2010. Twenty-three of the 367 tags injected into juvenile suckers (6.2 percent) were redetected (table 3). Nearly all redetected tags were 12 mm long; only three 8 mm tags were redetected, all in physically recaptured fish in 2011.

Individual fish histories provide information on the direction, distance, and timing of age-1 sucker movement. For example, one age-1 sucker collected and tagged in Short Creek on June 4, 2009, was subsequently detected moving up the Link River fish ladder into Upper Klamath Lake on August 5 and 6, 2009. It took this fish, which was 80 mm SL when tagged, less than 24 h to traverse all four antennas of the Link River fish ladder. Seven suckers PIT tagged in 2009 were detected on remote arrays at the Williamson River weir approximately 6 km upstream of the Williamson River Delta (fig. 1). Of these, one was detected on July 8, two were detected between June 4 and June 9, and three were detected between May 26 and June 11 and detected again between July 17 and August 30. The seventh PIT tagged sucker was tagged on April 17 in the Williamson River Delta, detected at the Williamson River weir 17 times between April 29 and June 9, detected downstream of, then upstream of the former site of the Chiloquin Dam on June 12, then detected two more times at the weir on July 16 and August 8, for a total travel distance of more than 20 km. No age-1 tagged suckers were detected at Braymill, the most upstream remote station.

Tag detections on bird colonies indicate predation was the cause of mortality for seven suckers tagged in April and May 2009 and two suckers tagged in 2010. Tags injected into these fish were detected October 1, 2009, or September 2, 2010, on American white pelican or double-crested cormorant breeding or loafing areas in the Upper Klamath National Wildlife Refuge (A. Evans, Real Time Research, written commun., October 29, 2009). Because both American white pelicans and double-crested cormorants primarily feed on live fish (Derby and Lvvorn, 1997), it can be assumed that these fish were eaten alive and did not die of other causes.

Discussion

This age-1 sucker tagging project is in the nascent stages, and has the potential to provide data essential to the understanding of juvenile sucker mortality and early life history in Upper Klamath Lake. Tag redetections on remote detection systems at spawning locations during known spawning seasons will provide confirmatory data on the age at which suckers first spawn. 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. Detection of tags on bird colonies will indicate the importance of bird predation to juvenile sucker mortality. Finally, data collected in this project may be useful for quantifying the degree to which fish survive from age-1 to adulthood.

The number of detections on remote antennas located in the Sprague and Williamson rivers was unexpected, given what is presently understood about Lost River and shortnose sucker life history. Similarly, 14 tagged age-0 and age-1 suckers salvaged from A and J canals and released into Upper Klamath Lake were detected at the Williamson River wier (A. Wilken, 2012, Bureau of Reclamation, oral commun.). These detections could be legitimate indications of age-1 endangered suckers moving into the rivers during the summer months. Tag detections also may indicate the presence of predators, such as Klamath redband trout (*Oncorhynchus mykiss* subsp.), rather than suckers. Because some tags were detected over several months, and stomach evacuation of trout is unlikely to take that long, we assume 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.

This study was limited by the number of suckers captured that were of a tagable size and by a low redetection rate. The efficiency of redetecting age-1 suckers increased between 2010 and 2011 due to a directed effort to capture this age class. An even greater number of age-1 suckers will need to be tagged and redetected, however, to accomplish the goals of this study. 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). In this study, our redetection rate was 6.2 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; Hewitt and others, 2010), 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, given that 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 survival, movement, and age to maturity depends on a large number of suckers being produced and surviving to age-1 so that they can be tagged as well as an increase in the number of tags redetected. The production of juvenile suckers cannot be controlled, thus, continued effort to capture and tag age-1 suckers will be required to take advantage of a large production event, if it does happen to occur. Based on above-average catches of age-0 suckers in Upper Klamath Lake during summer 2011 (D. Markle, Oregon State University, oral commun., 2012), catches of age-1 suckers also may be above average in 2012. Increased redetection effort on bird loafing and breeding areas in the Upper Klamath National Wildlife Refuge is planned for 2012, because it will likely increase the number of tags detected.

Acknowledgments

Data were collected with the help of Caley Boone, Daniel Brown, Jared Bottcher, Ryan Braham, Travis Ciotti, Megan Dethloff, Terra Kemper, James Latshaw, Randal Lodges, Nicholas Miller, Anna Willard, and Joline Willis. Alta Harris and Amari Dolan-Caret 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., 2012, 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., 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/*.)

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/*.)

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.

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.

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.

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.

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.

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.

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.

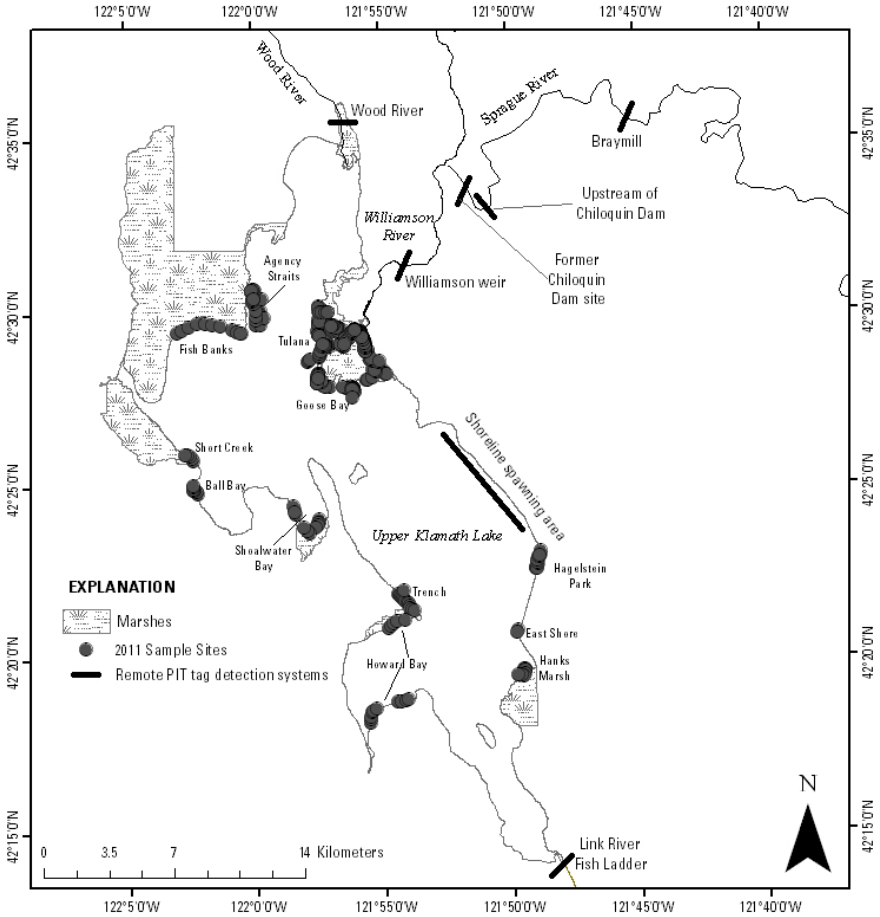

Figure 1. Map of study area, including sites fished for age-1 suckers in 2011, and locations of remote PIT tag detection systems. Sites sampled in 2009 and 2010 were randomly selected from Upper Klamath Lake and the southern one-third of Agency Lake and are not displayed here. All remote detection systems were active from 2009 to 2011, except the Wood River system, which will be active in spring 2012. The names of sampling areas are given on this map and the numbers of sites in each area are listed in table 2.

Table 1. Number of trap nets fished between May 9 and June 22, number of age-1 suckers given 8 mm and 12 mm PIT tags, and number of PIT tags redetected on remote sensing equipment or physically recaptured by year, Upper Klamath and Agency Lakes, Oregon, 2009–11.

[N/A, not applicable]

	Year		
	2009	2010	2011
Number of nets fished	1,075	936	488
Tagged with 8 mm	0	6	73
Tagged with 12 mm	162	34	92
Detected on remote antennas	8	6	5
Recaptured in juvenile sampling	0	0	3
Detected on bird colonies	6	3	N/A

Table 2. Number and location of trap nets set and catch rates for age-1 suckers by sampling area in Upper Klamath Lake, Oregon, 2011.

[Sample locations are shown in figure 1]

Area	Number of nets	Age-1 suckers per net set
Agency Straits	10	0.00
Ball Bay	8	0.00
East Shore	2	0.00
Fish Banks	11	0.00
Goose Bay	266	0.75
Hagelstein Park	10	0.08
Hanks Marsh	10	0.00
Howard Bay	15	0.00
Shoalwater Bay	12	0.00
Short Creek	5	0.00
Trench	13	0.00
Tulana	126	0.09

Table 3. Number of age-1 suckers tagged and redetected or recaptured each year, Upper Klamath Lake, Oregon, 2009–11.

		Year redetected		
Year tagged	Number tagged	2009	2010	2011
2009	162	14	5	2
2010	40		4	1
2011	165			5

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/