A small scale radio bio-telemetry study to monitor migrating Pacific Lamprey (*Lampetra tridentata)* within the Klamath River basin

Final Progress Report
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Barry W. McCovey Jr.

Yurok Tribal Fisheries Program
Klamath River Division
Hwy. 96, Weitchpec Route Box 196
Hoopa, CA 95546

Photo: Klamath River Pacific Lamprey (photo courtesy of Thomas Dunklin).

INTRODUCTION

In an effort to address the lack of knowledge concerning Pacific lamprey in the Klamath River, the Yurok Tribal Fisheries Program (YTFP) initiated a pilot study of adult migration in 2006. This was a two year study designed to identify the biotelemetry method that would be most appropriate to study Klamath River Pacific lamprey. In 2006 phase 1 of this study was initiated and a small number of lamprey were tagged using acoustic tags. This method proved to be unsuitable, as high turbidity levels typical during winter and spring flows made detecting the tags impossible. In 2007 phase 2 began and we investigated the feasibility of using radio biotelemetry to study movements and distribution of Pacific lamprey adults in the Klamath River. After this pilot study was completed, it was determined that radio biotelemetry methods were successful at tracking lamprey movements and any future studies should employ this technique.

In 2010 the YTFP conducted a small scale radio biotelemetry study to assess the migration and behavior of adult Pacific lamprey in the Klamath River watershed. The objectives of this study were to:

1. Document migration behaviors in the Klamath River;
2. Identify any possible spawning locations;
3. Document the amount of time adult Pacific lamprey spend in freshwater prior to spawning.

Other researchers have found that Pacific lamprey can spend over a year in freshwater before spawning (Scott and Crossman 1973; Farlinger and Beamish 1984; Bayer et al. 2000). If this behavior is also true for Klamath River Pacific lamprey, it would mean that they are impacted by a number of riverine issues that are directly related to the management of the Klamath River. In order to accurately analyze the duration of river residency we used radio transmitters that have a lifespan of 440 days. The tags used during our 2007 pilot study had a life expectancy of only 150 days, which is too short to properly document freshwater residency. Transmitters used in our 2010 study will expire between June 20th and August 15th of 2011. This is an ongoing project and will continue until the life span of the transmitters has ended. This correspondence is intended to update the progress of this project as of September, 2010. A complete final report will be produced in a timely manner after all field work activities have ceased.

MATERIALS AND METHODS

Tagging efforts began on April 6th, 2010 and ended on June 2nd, 2010. We captured adult Pacific lamprey on the south spit of the Klamath River estuary directly adjacent to the "chute" at the river's mouth were it joins the Pacific Ocean (Figure 1). We netted lamprey using eight foot long dip nets with a hoop diameter of 120 cm, a pouch approximately 150 cm deep, and a mesh size of 1 cm. The fish were dipped out of small waves as they attempted to enter the estuary. Upon capture, the lamprey were stored in a lidded cooler filled with river water or in submerged plastic live tubes until tagged. This holding period lasted no more than four hours.

Captured lampreys were anaesthetized a solution of 70 mg/L buffered tricaine methanesulfonate (MS-222) for 5-7 min. Prior to the surgical procedure a total body length measurement was taken, a genetic sample was taken from the dorsal fin, and we measured the mid girth (body circumference anterior to first dorsal fin). A mid girth measurement of greater than 100 mm was determined to be the minimum size requirement for the surgical process to take place (all captured lamprey were found to be well over the minimum). A 2 cm ventral incision was made approximately 1 cm anterior to the insertion of the first dorsal fin. A coded Lotek Nano radio tag (Lotek Wireless model number NTC-6-2; 149 mHz) was inserted into the abdominal cavity. The radio transmitters had a burst rate of five seconds, an air weight of 2.0 g, an in-water weight of 0.2 g, and measured 9 by 19 mm. A three volt battery powered the tags which had a life expectancy of 440 days. A 12 gauge hollow needle was used to thread the trailing radio antenna through the abdominal wall. The trailing antenna length was approximately 12 inches. Three interrupted cross stitches were made to close the incision using a 4.0 Prolene blue monofilament polypropylene suture, which was 45 cm in length, and attached to a FS-2 cutting needle. A commercial anti-bacterial ointment was then applied to the completed sutures. A 25 mm Floy tag was attached to the base of the first dorsal fin. This tag was labeled with the words “do not eat” to deter local fisherman from consuming lamprey that had been anesthetized with MS-222. Tagged lamprey were put into individual live tubes, which were submerged in the estuary for a 30 minute recovery period. All tagged lamprey were transported and released near the Requa boat ramp (rkm 1).

An array of seven Orion (Sigma Eight Engineering) radio listening stations were used to track lamprey migration. Five stations were located on the mainstem Klamath River and two were installed on the Trinity River (Figure 2). Information from each station was downloaded on a weekly basis until July 2, 2010, at which point each station was monitored on bi-weekly until winter conditions made the stations inoperable. Manual tracking surveys were conducted on a weekly basis upstream of areas where station detections had confirmed the presence of tagged lamprey. These weekly manual tracking surveys continued until the end of August when YTFP personnel began working on other projects. At this point manual tracking surveys were conducted approximately twice a month.

Mainstem Klamath River temperatures were monitored during this project by the YTFP at rkm 72 using an Onset Hobo Pro V2 water temperature data logger. Klamath River discharge was measured by the USGS gauging station at rkm 13 near Klamath, California (site #11530500).

RESULTS

Between April 6th, 2010 to June 2nd, 2010 a total of 23 adult Pacific lamprey were captured, tagged, and released. Total body lengths averaged 61.5 cm and ranged from 57 to 66 cm (Table 1).

As of September 2010, 18 of the 23 tagged lamprey were detected by our listening stations, or by manual tracking. Tagged Pacific lamprey were detected between two and eleven times each, with a total of 135 confirmed detections. Tagged lamprey were confirmed as far as 212 km upstream from the tagging location. The average distance traveled was 102 km upstream (Table 2).

Tagged Pacific lamprey movements were generally upstream in nature and most continued migrating until a time window between July 1st and August 1st. At this point in time the majority of these tagged fish stopped their upstream migration and initiated a holding period, which coincided with the onset of summer high water temperatures and low flows (Figure 3).

During the time period when tagged Pacific lamprey were detected migrating upstream in the Klamath River (April 6th through September 1st), mainstem temperatures ranged from 7.1 to 23.6°C at rkm 72 (Figure 4). During this same time period mainstem Klamath River discharge ranged from 32,600 cubic feet per second (cfs) to 3,410 cfs at rkm 13 (Figure 5).

SUMMARY

After tagging, 18 of 23 (78%) Pacific lamprey were detected making upstream migrations in the mainstem Klamath River. The majority of these tagged lamprey continued moving upstream until the time period between the beginning of July and the beginning of August. Mainstem Klamath River temperatures increased from 17.3 to 23.5°C during this time frame and flows approached summer low flow conditions. At this point most tagged lamprey ceased active upstream migration and initiated a holding behavior. Tagged lamprey were observed holding at various locations between rkm 61 and rkm 212 in the mainstem Klamath and Trinity rivers. The holding behavior occurred during a relatively consistent period in time as opposed to location, although migration generally slowed as fish approached the confluence of the Klamath and Trinity rivers at Weitchpec (rkm 70). Similar holding behavior has been observed in other telemetry studies of Pacific lamprey.

After September 1st, the frequency of manual tracking surveys decreased as crews were obligated to begin other projects. Also, the onset of fall conditions limited the ability of our fixed receiver stations to remain powered by solar energy. These stations were eventually removed as winter approached and it became clear that they would no longer function without substantial improvements. Manual tracking surveys were conducted on a very limited basis during the fall and winter of 2010. These surveys occurred when field crews had available time and as limited funding allowed. In general, tagged lamprey appeared to hold in the same locations until significant increases in discharge occurred. These bank full events took place in December and were some of the highest flows during this study. When field crews surveyed in late December, they found most lamprey had vacated the holding areas and were not in the immediate vicinity. It is not

known where these lamprey went, but the primary explanations are that they migrated up into tributaries or were pushed or retreated back downstream. A comprehensive manual tracking survey of the entire mainstem Klamath and Trinity rivers will be conducted in April of 2011 and biweekly surveys will continue after this point. A complete report on all of our findings will be produced after all of the transmitters have expired and all data analysis has been conducted. This will be no later than December 31st, 2011.

ACKNOWLEDGEMENTS

The YTFP commends our hard working staff for persevering in cold and gnarly weather conditions to capture and tag these amazing fish for the purpose of completing this unique study. This study was funded by the Bureau of Reclamation's Klamath Basin Area Office.

TABLES AND FIGURES

Figure 1: Satellite photo of Klamath River mouth. Circles indicates primary lamprey capture (left) and release (right) areas for 2010 YTFP Pacific lamprey bio-telemetry project (Google Earth 2007).

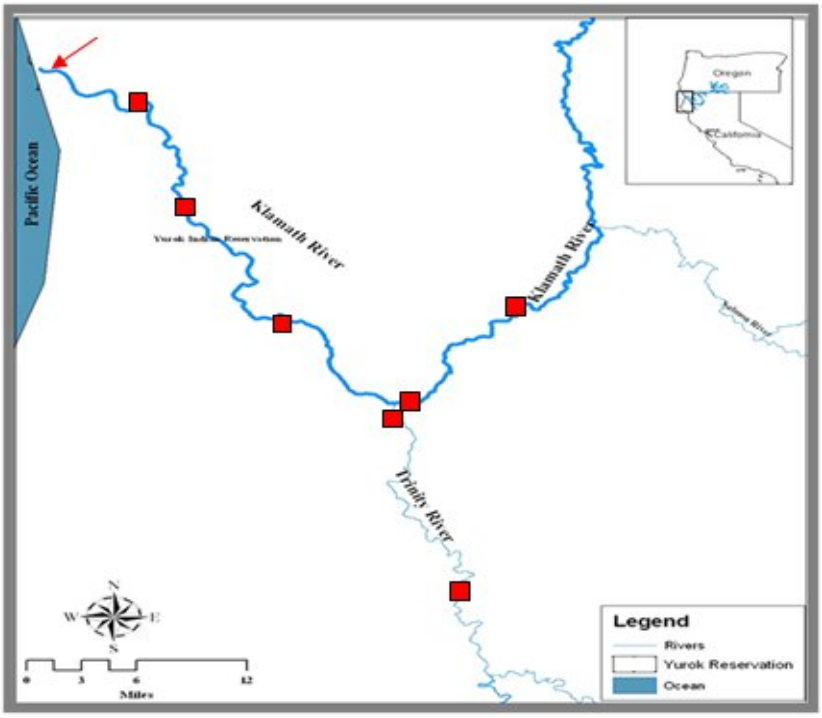

Figure 2: Map of 2010 Pacific lamprey bio-telemetry stations (squares) and the tagging and release location (arrow) for the Klamath and Trinity Rivers.

Table 1: Individual lamprey tagging data (n = 23). All fish were tagged at river kilometer 1. Sample number is also the code number of the transmitter that was implanted into the lamprey. Total body lengths are shown in centimeters (cm) and surgery time is expressed in minutes (min). Tag expiration date is based on the manufacture's predicted tag battery life of 440 days after the tag was activated.

Date Tagged	Sample Number	Length (cm)	Surgery Time (min)	Tag Expiration Date	Date Tagged	Sample Number	Length (cm)	Surgery Time (min)	Tag Expiration Date
4/6/2010	11	62	6.5	6/19/2011	4/15/2010	23	66	5	6/29/2011
4/6/2010	13	64	6	6/19/2011	4/15/2010	24	66	4	6/29/2011
4/6/2010	12	65	5	6/19/2011	4/22/2010	28	59	5	7/6/2011
4/6/2010	14	61.5	5	6/19/2011	4/22/2010	26	61	5	7/6/2011
4/6/2010	15	60	5	6/19/2011	4/22/2010	25	59.5	4	7/6/2011
4/7/2010	16	65.5	6	6/20/2011	5/7/2010	29	63.5	6	7/21/2011
4/7/2010	17	57	5	6/20/2011	5/13/2010	30	59	5	7/27/2011
4/7/2010	18	61	5	6/20/2011	6/2/2010	27	60	5	8/16/2011
4/7/2010	19	57	4	6/20/2011	6/2/2010	31	61	6	8/16/2011
4/14/2010	20	64.5	5	6/28/2011	6/2/2010	32	57	5	8/16/2011
4/14/2010	21	59	4	6/28/2011	6/2/2010	33	63	5	8/16/2011
4/15/2010	22	61	4	6/29/2011					

Table 2: Radio tracking detection summary for individual lamprey. Five individuals were never detected after tagging, therefore the distance migrated upstream is unknown. Distance migrated upstream is shown in river kilometers (rkm). The information presented in this table includes all data as of September 1st, 2010. Additional data will be included in the final report.

Date Tagged	Sample Number	Number of Detections	Distance Migrated Up-stream (rkm)	Date Tagged	Sample Number	Number of Detections	Distance Migrated Up-stream
4/6/2010	11	0	?	4/15/2010	23	10	166
4/6/2010	13	9	64	4/15/2010	24	9	61
4/6/2010	12	0	?	4/22/2010	25	4	117
4/6/2010	14	0	?	4/22/2010	26	5	95
4/6/2010	15	9	212	4/22/2010	28	11	98
4/7/2010	16	0	?	5/7/2010	29	5	61
4/7/2010	17	0	?	5/13/2010	30	11	100
4/7/2010	18	4	12	6/2/2010	27	9	87
4/7/2010	19	11	118	6/2/2010	31	3	69
4/14/2010	20	8	199	6/2/2010	32	9	104
4/14/2010	21	6	100	6/2/2010	33	4	96
4/15/2010	22	8	71				

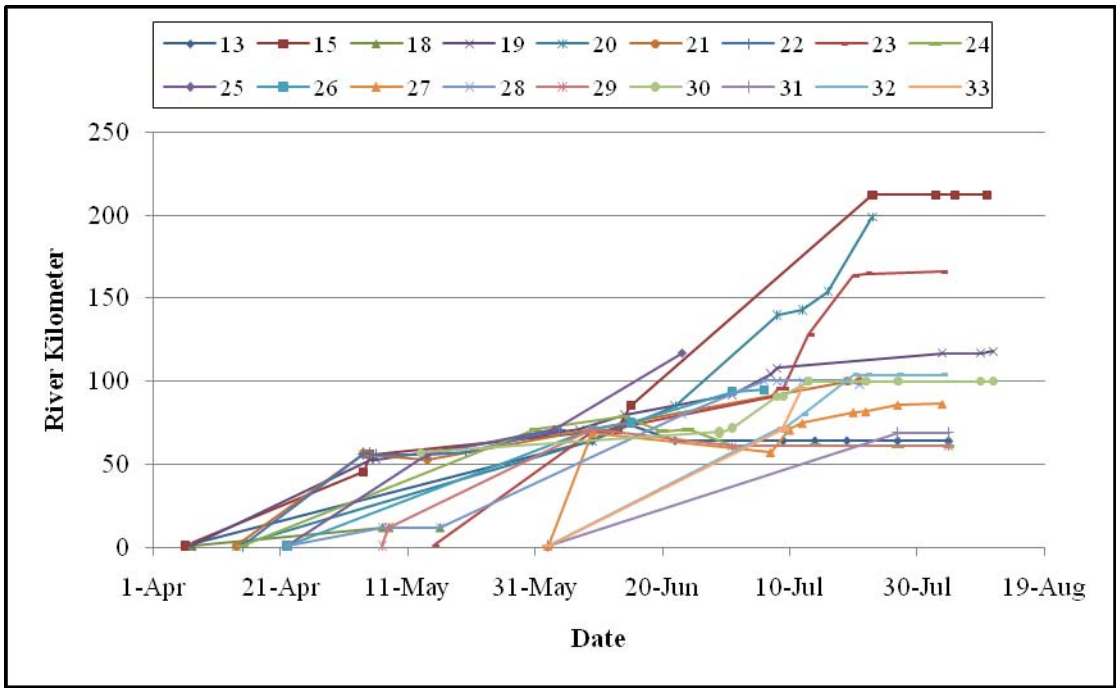

Figure 3: Migration summary for the 2010 YTFP Pacific lamprey bio-telemetry project. Each line represents the movements of an individual tagged adult lamprey (*n* = 18) and each mark on a line signifies a distinct detection. The first mark on each line indicates the date and rkm that the tagged lamprey was released. The confluence of the Klamath and Trinity rivers is at rkm 70.

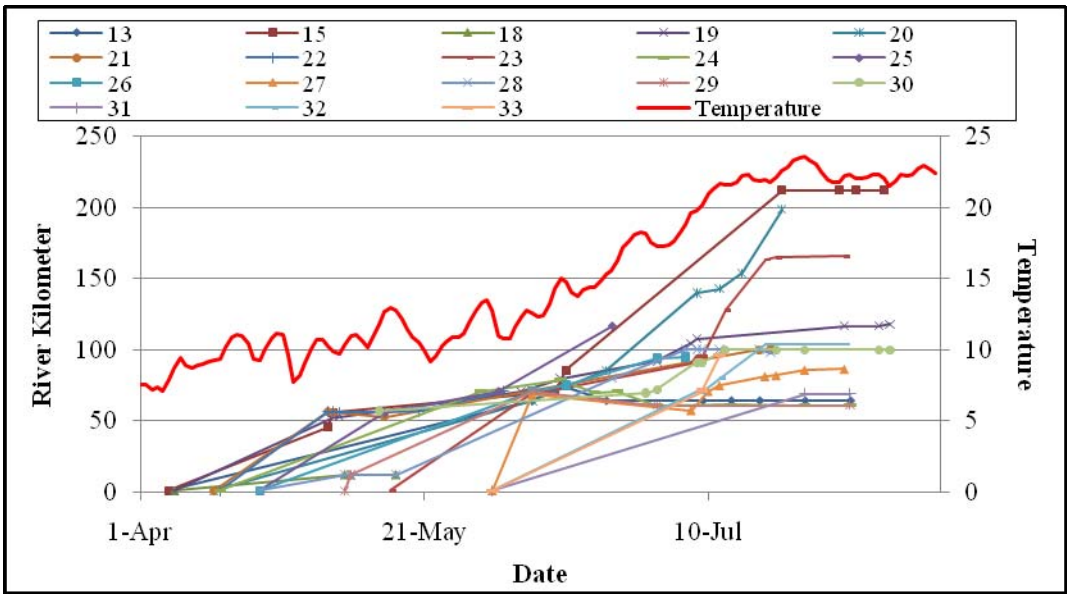

Figure 4: Migration summary for the 2010 YTFP Pacific lamprey bio-telemetry project in relation to river temperature. Mainstem Klamath River temperatures (°C) were recorded at rkm 72. The slowed migration around the confluence of the Klamath and Trinity rivers was not associated with warm water temperatures but the subsequent holding behavior at differing locations was associated with high water temperatures above approximately 22°C.

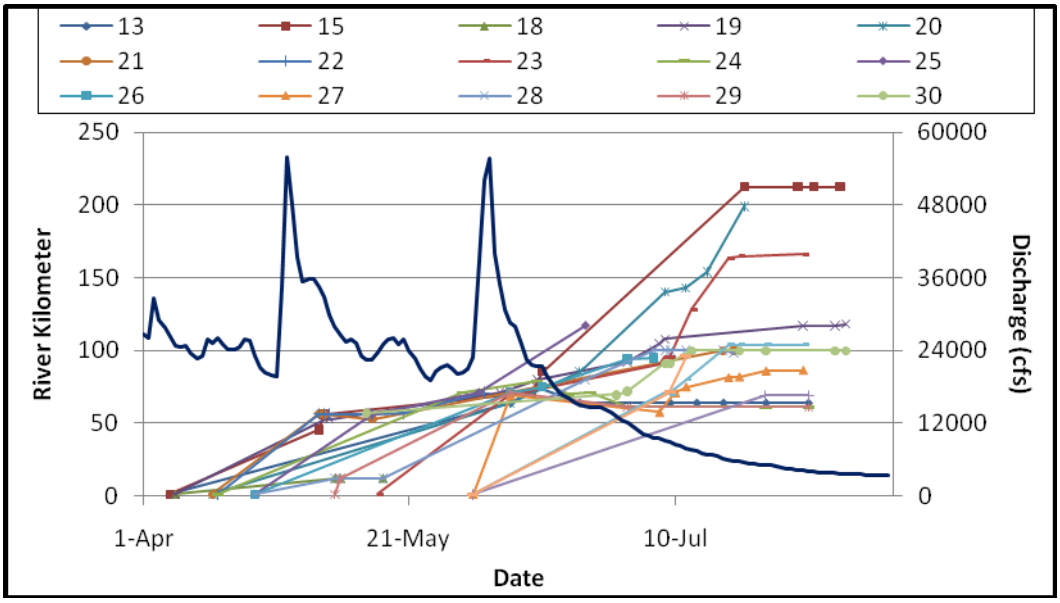

Figure 5: Migration summary for the 2010 YTFP Pacific lamprey telemetry project in relation to river discharge. Mainstem Klamath River discharge (cfs) was measured at rkm 13. The slowed migration around the confluence of the Klamath and Trinity rivers was not associated with a specific flow but the subsequent holding behavior at differing locations was associated with declining flows approaching summer minimums.

LITERATURE CITED

Bartholow, J. M. 2005. Recent water temperature trends in the Lower Klamath River, California. North American Journal of Fisheries Management 25:152-162.

Beamish, R.J. 1980. Adult biology of the river lamprey *(Lampetra ayersi)* and the Pacific lamprey *(Lampetra tridentata)* from the Pacific coast of Canada. Canadian Journal of Fisheries and Aquatic Sciences 37:1906-1923.

Beamish, R.J. and C.D. Levings. 1991. Abundance and freshwater migrations of the anadromous parasitic lamprey, *Lampetra tridentata*, in a tributary of the Fraser River, British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 48: 1250-1263.

Belchik, M.R. and Z.S. Larson. 1998. A preliminary status review of eulachon and Pacific lamprey in the Klamath River Basin. Yurok Tribal Fisheries Program Technical Report.

Close, D.A., M.S. Fitzpatrick, and H.W. Li. 2002. The ecological importance of a species at risk of extinction, Pacific lamprey. Fisheries 27: 19-25.

Close, D. A., M. S. Fitzpatrick, C. M. Lorion, H. W. Li, and C. B. Schreck. 2003. Effects of intraperitoneally implanted radio transmitters on the swimming performance and physiology of Pacific lamprey. North American Journal of Fisheries Management 23:1184-1192.

Farlinger, S.P. and R.J. Beamish. 1984. Recent colonization of a major salmon-producing lake in British Columbia by Pacific lamprey (*Lampetra tridentata*). Canadian Journal of Fisheries and Aquatic Sciences 41: 278-285.

Hardisty, M.W. and I.C. Potter. 1971. The general biology of adult lampreys. P 127-206 *In* M.W. Hardisty and I.C. Potter [eds.]. The biology of lampreys. Vol 1. Academic Press Inc., London.

Michael, J.H. Jr. 1984. Additional notes on the repeat spawning by Pacific lamprey. California Fish and Game 70: 186-188.

Mesa, Matthew G., Jennifer M. Bayer, and James G. Seelye. 2003. Swimming performance and physiological responses to exhaustive exercise in radio-tagged and untagged Pacific lampreys. Transactions of the American Fisheries Society 132:483-492.

Moffet, J.W. and S.H. Smith. 1950. Biological investigations of the fishery resources of Trinity River, California. USFWS Special Scientific Report on Fish. 12. 71 pp.

Moyle, P.B. 2002. Inland fishes of California. University of California Press, Berkeley, California. 502 pp.

NRC (National Research Council). 2002. Scientific evaluation of Biological Opinions on endangered and threatened fishes in the Klamath River Basin: Interim report. National Academy Press, Washington DC.

Roffe, T.J. and B.R. Mate. 1984. Abundances and feeding habits of pinnipeds in the Rogue River, Oregon Journal of Wildlife. Management 48(4); 1262-1274.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184.

Wydoski, R.S. and R.R. Whitney. 1979. Inland fishes of Washington. University of Washington Press, Seattle, Washington. 270 pp.