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Determining Lamprey Species Composition, Larval Distribution, and Adult Abundance in the Deschutes River, Oregon, Subbasin

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DETERMINING LAMPREY SPECIES COMPOSITION, LARVAL DISTRIBUTION, AND ADULT ABUNDANCE IN THE DESCHUTES RIVER SUBBASIN, OREGON,

2005 Annual Report

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ABSTRACT

Information about lamprey species composition, distribution, life history, abundance, habitat requirements, and exploitation in the lower Deschutes River Subbasin is extremely limited. During 2002, we began a multi-year study to assess the status of lamprey in the Deschutes River subbasin. The objectives of this project are to determine ammocoete (larval lamprey) distribution and associated habitats; *Lampretra* species composition; numbers of emigrants; adult escapement and harvest rates at Sherars Falls.

This report describes the preliminary results of data collected during 2005. We continued documenting ammocoete (larval) habitat selection by surveying four perennial eastside tributaries to the Deschutes River (Warm Springs River, Badger, Beaver and Shitike creeks) within the known ammocoete distribution. The results of 2003-2005 sampling indicate that positive relationships exist between: presence of wood (P = < 0.001), depositional area (P = < 0.001), flow (P = < 0.001), and fine substrate (P = < 0.001).

Out-migrants numbers were not estimated during 2005 due to our inability to recapture marked larvae. In Shitike Creek, ammocoete and macropthalmia out-migration peaked during November 2005. In the Warm Spring River, out-migration peaked for ammocoetes in April 2006 and December 2005 for macropthalmia. Samples of ammocoetes from each stream were retained in a permanent collection of future analysis.

An escapement estimate was generated for adult Pacific lamprey in the lower Deschutes River using a two event mark-recapture experiment during run year 2005. A modified Peterson model was used to estimate the adult population of Pacific lamprey at 3,895 with an estimated escapement of 2,881during 2005 (95% CI= 2,847; *M* = 143; *C* = 1,027 *R* = 37). A tribal creel was also conducted from mid-June through August. We estimated tribal harvest to be approximately 1,015 adult lamprey during 2005 (95% CI= +/- 74).

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INTRODUCTION

There are three species of lamprey endemic to the Columbia River Basin (CRB). Two of which, Pacific lamprey and river lamprey, are anadromous (Beamish 1980). The third, western brook lamprey, completes it's lifecycle in freshwater (Beamish et al. 1982). Little information is available on the distribution and abundance of river lamprey or western brook lamprey within the CRB, although, a few studies in Canada have described their biology (Beamish 1987; Beamish 1980; Beamish and Withler 1986; Beamish and Youson 1986; Richards et al. 1982; Vladykov and Follett 1965; and Vladykov and Follett 1958). While life history information is available on Pacific lamprey there are many critical uncertainties (Beamish 1980; Beamish and Levings 1991; Close 1995; Pletcher 1963; Scott and Crossman 1973; van de Wetering 1998). Currently multiple projects are underway in the CRB to address some of these uncertainties (Bayer et al. 2000; 2001; 2002; Close et al. 1995; Close 1998; 1999; 2000; 2001; Jackson 1996; 1997).

Pacific lamprey were once widely distributed throughout the CRB (Kan 1975; Wydoski and Whitney 1979) but have dramatically declined since the 1940's (Close et al. 1995). Sparse information is available on historic lamprey numbers and distribution. Dam counts through the CRB have been used to assess declining trends in upstream migrating Pacific lamprey (Kostow 2002). In 1993, the state of Oregon listed Pacific lamprey as a sensitive species and increased their protection status in 1997 (OAR 635-044-0130) (Kostow 2002).

There are many potential factors leading to the decline of Pacific lamprey. Poor mainstem passage is cited as a major cause for the decline (CBPLTWG 1999; Kostow 2002; Long 1968; Vella et al. 1999a; Vella et al. 199b). Lack of "lamprey friendly" screening may also present a problem at hydroelectric facilities (Kostow 2002). Degraded tributary habitat including decreased flows, increased water temperatures, and poor riparian habitat may also explain the apparent decrease in abundance (CBPLTWG 1999; Close et al. 1995).

Many feel the ecological, economic, and cultural significance of Pacific lamprey has been underestimated (Close et al. 1995; CRITFC 1995; Kan 1975; NPPC 1995). For the Native American tribes of the Pacific Coast, Pacific lamprey are an important subsistence, ceremonial, and medicinal resource (Close et al. 1995; CRITFC 1995; Hunn and Selam 1991; Pletcher 1963). The people of Confederated Tribes of Warm Springs Reservation, Oregon (CTWSRO) harvest Pacific lamprey at Sherars Falls in the lower Deschutes River. Lack of sufficient numbers of Pacific lamprey for cultural needs have forced tribal harvesters to collect lamprey at alternate locations including Willamette Falls, on the Willamette River, located in Oregon City, Oregon.

Information about lamprey species composition, abundance, habitat requirements, and exploitation in the lower Deschutes River tributaries are extremely limited (Kan 1975; Hammonds 1979; Beamish 1980). In order to formulate an effective recovery plan for Deschutes River lamprey, baseline biological information must first be collected and analyzed. The objectives of this project are to: (1) determine ammocoete distribution and associated habitats in the lower Deschutes River subbasin; (2) determine species composition in the lower Deschutes subbasin; (3) estimate the number of lamprey emigrants, by developmental stage, from Warm Springs River and Shitike Creek; and (4) conducting a mark-recapture study to estimate the escapement of adult lamprey over Sherars Falls and estimate the lamprey harvest at Sherars Falls.

STUDY AREA

The lower Deschutes River subbasin is located in central Oregon. It drains the east slopes of the Cascade mountain range (approximately 6,993 km^2) with 1,223 km of perennial streams and 2,317 km of intermittent streams. A series of hydro-electric dams begin at Rkm 161. Lamprey passage does not exist at these facilities. Major tributaries of the lower Deschutes River are White River, Warm Springs River and Shitike Creek to the west and Buck Hollow, Bakeoven, and Trout creeks to the east.

The majority of perennial tributaries within the lower Deschutes River subbasin originate within the boundaries of the Confederated Tribes of Warm Springs Reservation. The Reservation covers 240,000 ha. on the eastern slopes of the Cascade Mountains. The Reservation boundaries are the crest of the Cascades to the north and west, Deschutes River to the east and Metolius River to the south. The Warm Springs River is the largest watershed within the Reservation, flowing 85 kilometers and draining 54,394 ha. It is the largest tributary to the lower Deschutes River. Major tributaries to the Warm Springs River are Beaver and Mill creeks. Shitike Creek is the third largest tributary to the lower Deschutes River flowing for 48 Rkm and draining 36,000 ha.

Figure 1. Map showing the location of the Confederated Tribes of the Warm Springs Reservation, Oregon.

SECTION I
AMMOCOETE (LARVAL) DISTRIBUTION AND HABITAT ASSOCIATIONS

Methods

Ammocoete habitat association surveys were conducted from May – October 2005, in perennial tributaries to the lower Deschutes River. Within the known distribution, random locations were sampled for ammocoete presence in type-I and type-II habitats (Hansen et al. 2003) (Table I-1). A hierarchical random stratified sampling design was used to determine habitat relationships. The sampling design was developed and successfully utilized by Torgersen and Close (2000) to document ammocoete distribution and habitat in the John Day subbasin. The sampling methodology consists of three tiers: Level I-stream reach, Level II-transect, and Level III-sub-sample (Figure I-1).

Tier I -- Reach: Perennial streams were divided into 10 Rkm reaches from the mouth to the upstream extent of perennial stream flow or impassible barriers. Reaches were identified using 1:75,000 quadrant maps digitized in ArcView®. Within each reach, one 60 m long sampling point was randomly selected. Locations of each sample reach were recorded using a Global Position System (GPS).

Tier II -- Transect: Six transects were located within each Level 1 survey reach. Transects were placed perpendicular to the stream flow. Each transect was located at 10 m intervals.

Tier III -- Sub-sample: Two sub-samples were surveyed along each Level II transect. Two one meter squared sub-samples was randomly located along each transect. When stream were less than 3 m wide (wetted channel width) sub-samples were located successively in an upstream direction with approximately 1 m between sub-samples.

An AbP-2 Wisconsin electrofishing unit was used to capture ammocoetes within each sub-sample. The unit is specifically designed to capture ammocoetes (O'Neal 1987). Shockers delivered a constant 125 V at a rate of 3 pulse/s with a pulse train of 3:1 (Pajo and Weise 1994). Two, 90 second electrofishing passes were applied to each sub-sample. Captured ammocoetes were anesthetized with MS-222 and measured for length to the nearest mm. *Lampetra* species were identified (refer to objective 2). Fish were released at the sampling point after recovering from anesthesia. All other species observed during electrofishing were enumerated and recorded.

Habitat and water chemistry data was collected at each tier (Table I-2). Associations of ammocoete presence with physical habitat characteristics were analyzed using multiple logistic regressions. Results were related to the distribution of ammocoetes to stream habitat characteristics within the range of habitats available in the lower Deschutes subbasin. A GIS map was generated to display the distribution of ammocoetes within the surveyed streams (Appendix A).

Table I-1. Type-I, -II, and -III ammocoete habitat substrate definitions used in lower Deschutes River tributaries, 2005.

Type	Substrate
I - Preferred	Sand, fine organic matter including detritus and aquatic vegetation
II - Acceptable	Shifting sand, gravel, rubble, little or no organic matter
III - Unacceptable	Bedrock, hardpan clay with rubble and coarse gravel

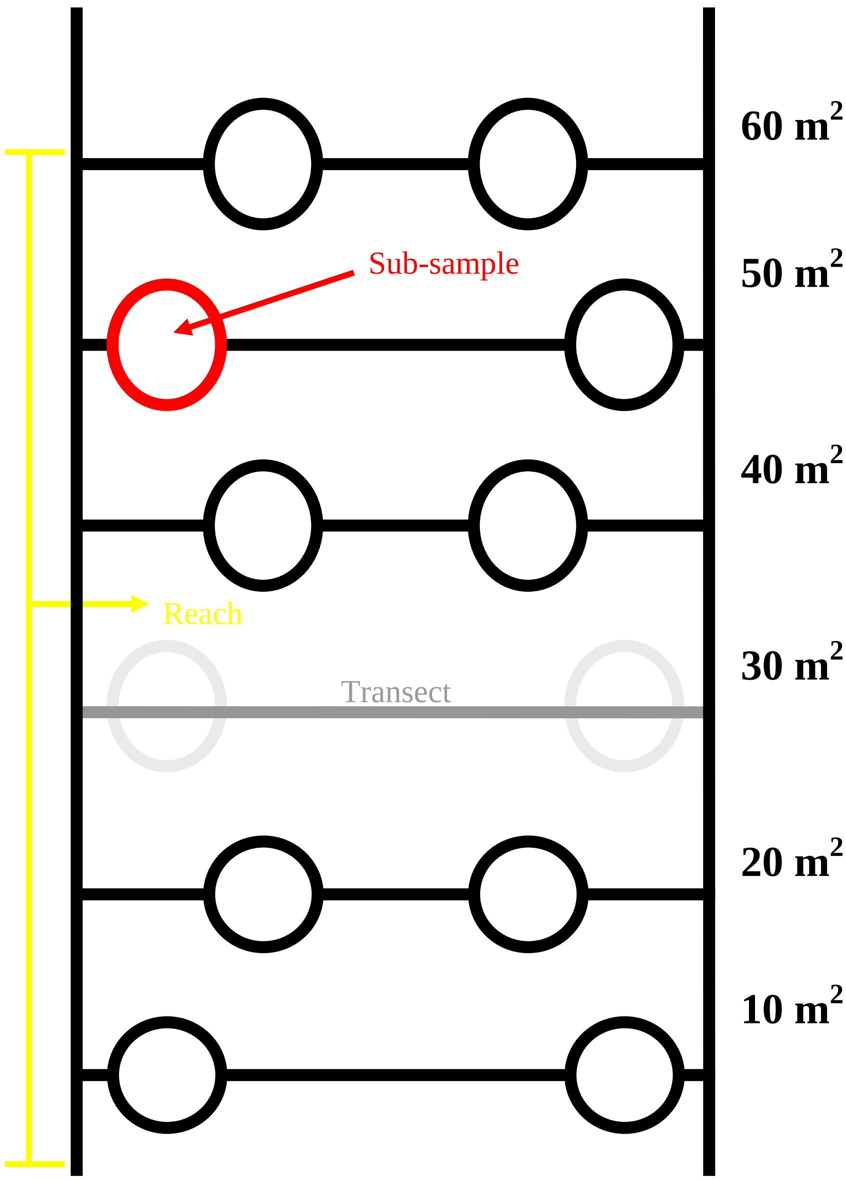

Figure I-1. Diagram of hierarchical random stratified sampling design used in the lower Deschutes River subbasin, 2005.

Table I-2. Habitat and water quality data to be collected at each sampling tier in the lower Deschutes River Subbasin, 2005.

Habitat and Water Chemistry Parameters	Level I Sample Reach	Level II Transect	Level III Sub-Sample
Conductivity	X		
H_2O Temperature	X		
Mean Water Depth			X
Mean Water Velocity			X
Substrate Type			X
Channel Unit Type (riffle, pool, etc)			X
Wetted Channel Width		X	
Bankfull Channel Width		X	
Channel Slope	X		
Canopy Density		X	

Results and Discussion

In 2005, sampling was conducted within the known ammocoete distribution in order to determine if habitat preferences could be established. However, because the AbP-2 backpack electrofisher efficiency is unknown, the density estimates should only be used as a measurement of trend.

We completed a total of 108 sub-samples within the known ammocoete distribution (Table I-3.) Ammocoetes were present in 69 (63.9%). We collected 336 ammocoetes ranging in length from 24 mm – 105 mm with a mean length of 77.9 mm.

Physical habitat was classified into four categories: alcove, glide, pool and fast water (e.g., riffles, rapids, cascades). In 2005, pools were present in the majority (31.3%) of sub-samples followed by glides (25.0%), fast water (22.9%), and alcoves (20.3%). Ammocoetes were present in 93.3%, 80.0%, 75.0%, and 27.3% of pools, alcoves, glides, and fast water, respectively (Table 4-4).

We found multiple relationships between ammocoete presence and habitat variables when 2003-2005 data was pooled. Relationship were found with ammocoete presence and wood (P = <

Table I-3. Stream, number of sites and ammocoete presence during ammocoete distribution surveys in the lower Deschutes River Subbasin, 2005.

Streams Sampled	Presence/Absence	Reaches Sampled	End of Distribution (Rkm)
Badger Creek	Present	2	11
Beaver Creek	Present	2	21
Shitike Creek	Present	1	11
Warm Springs River	Present	3	55
White River	Present	1	1

0.001). Woody debris was not classified by size category (diameter breast height or length), only by presence or absence. We also found that depositional area (P = <0.001) is a good indicator of ammocoete presence. Depositional area was characterized by the presence of soft substrate (silt or fine sand), generally containing large amounts of organic debris located near stream margins.

Positive relationships were found with flow (P = <0.001) and mean depth of fine substrates (P = <0.001). Ammocoetes were collected in water velocities ranging from 0 – 9.48 m/s with a mean of 0.91 ft/s. They were also collected in a wide range of fine substrate depths (0 – 620 mm; mean = 49.09 mm).

SECTION II
DETERMINE DEVELOPMENTAL STAGES AND SPECIES COMPOSITION OF *LAMPETRA*

Methods

It is currently unknown what *Lampetra* species other than Pacific lamprey are present in the Deschutes River subbasin. Species identification for ammocoetes in the field is problematic due to similar morphologies (Richards 1980, Bond 1977).

During ammocoete distribution surveys lamprey were classified into three developmental categories (A, B and C) based upon similar external morphological characteristics described by Richards et al. (1982). In locations where ammocoetes in stage A were abundant, sub-samples were sacrificed and preserved in a 4-5% ethanol solution. Stage A is defined by the presence of an eye (dark spot) and a mouth being fully surrounded by the oral hood.

Specimens of known species were placed in a permanent collection to aid in species identification during future field surveys.

Results and Discussion

In 2005, we identified Pacific lamprey in three life phases: ammocoetes, macropthalmia, and adult. Ammocoetes were identified during ammocoete distribution efforts. Out-migrants (ammocoetes and macropthalmia) were identified in the Shitike Creek and Warm Springs River screw traps. Adult Pacific lamprey were identified at Sherars Falls during the summer upstream migration.

Specimens were collected during operation of rotary screw traps in the Warm Springs River and Shitike Creek. All ammocoetes collected were stage A Pacific lamprey. A total of 30 samples were collected from rotary screw traps in Shitike Creek and the Warm Springs River. They will be identified to species in the laboratory at a later date. No western brook or river lamprey were initially identified.

SECTION III
ESTIMATE THE NUMBER OF LAMPREY EMIGRANTS

Methods

A 1.5 m cone diameter floating rotary screw trap was operated in Shitike Creek (Rkm 1.2) from April - June 2005, September – December 2005, and March – April 2006. A 2.4 m cone diameter floating rotary screw trap was also fished in the Warm Springs River (Rkm 1.5) from April - May 2005, September – December 2005, and March – April 2006. Both traps were operated 5 days/week, 24 hrs/day and checked once per day except in high water conditions when the trap was checked more frequently to remove debris. During extreme high or low water conditions the traps were removed.

Captured lamprey were anesthetized with MS-222, identified to species, developmental stage recorded, total length measured, weighed, and checked for anomalies. After recovering from anesthesia lamprey were released below the trap site.

River flows were monitored at USGS gaging stations located in Shitike Creek (USGS gaging station 14093000) and the Warm Springs River (USGS gaging station 14097100) throughout the trapping period. This information will be used to compare emigrant timing with stream discharge to determine if there is a significant relationship among years.

We evaluated trap holding efficiencies for the Shitike Creek and Warm Springs River rotary screw traps three times from April 2005 – March 2006. Fifty fish of multiple length classes were collected using a backpack electrofisher. Collected lamprey were anesthetized, total length measured, weighed, marked with elastomer dye and placed in screw trap holding boxes for 24 hours. After 24 hours, we recollected marked lamprey from the holding boxes and the number of lamprey with elastomer marks were enumerated.

Results and Discussion

Shitike Creek

Out-migrant lamprey were collected 49 of the 102 days the rotary screw trap was fished in Shitike Creek (Appendix A). A total of 598 Pacific lamprey were collected in the Shitike Creek trap. Of those, 582 were ammocoetes (97.3% total catch) and 16 macropthalmia.

The maximum, minimum and mean length of ammocoetes collected in the Shitike Creek trap was 209 mm, 57 mm and 94 mm, respectively. The length frequency for out-migrants in Shitike Creek is displayed in Figure III-1. Pacific lamprey macropthalmia lengths ranged from 92 mm – 165 mm with a mean of 130 mm.

Warm Springs River

Out-migrant lamprey were present in the Warm Springs rotary screw trap 41 of 114 days the trap fished. In total 172 Pacific lamprey were collected. Ammocoetes made up majority of the catch at 80.2%.

The maximum, minimum and mean length of Pacific lamprey ammocoetes collected in the Warm Springs River trap was 160 mm, 43 mm and 112 mm, respectively (Appendix A). Pacific lamprey macropthalmia lengths ranged from 94 mm – 142 mm with a mean of 120 mm. Length frequencies for out-migrants can be found in Figure III-2.

Out-migration timing

Peak out-migration in Shitike Creek for ammocoetes and macropthalmia was observed in November 2005 with 17 ammocoetes/day and 1 macropthalmia/day, respectively (Figure III-3). Out-migrant lamprey were collected in the Shitike Creek trap during all months of operation. Peak out-migration timing for macropthalmia (1.33/day) and ammocoetes (3.75/day) in the Warm Springs River was during December 2005 and April 2006, respectively (Figure III-4). Out-migrant lamprey were absent from catches in the Warm Springs River during September 2005. Based upon river discharge during January and February, when screw traps were not operated, it is possible a large number of out-migrants departed the system.

Trap Holding Efficiencies

Despite modifications to the Shitike Creek screw trap holding box prior to the 2005 sampling period holding efficiencies remained at zero in all screw traps. The number of out-migrants could not be estimated during 2005 due to the inability of the screw trap holding boxes to retained marked ammocoetes.

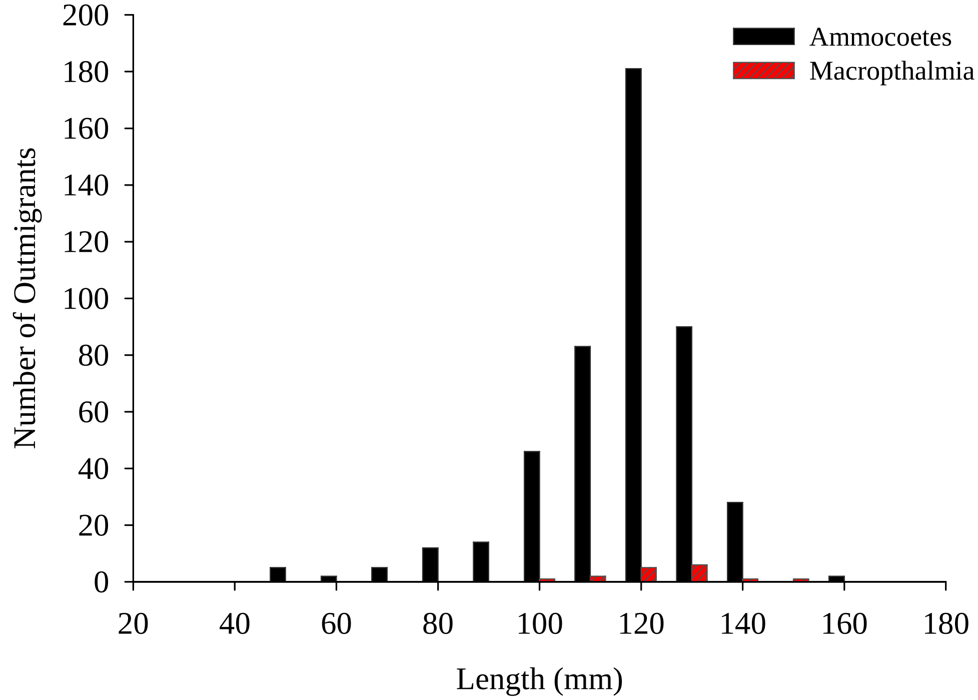

Figure III-1. Length frequency for out-migrants collected in the Shitike Creek rotary screw trap, April 2005 – April 2006.

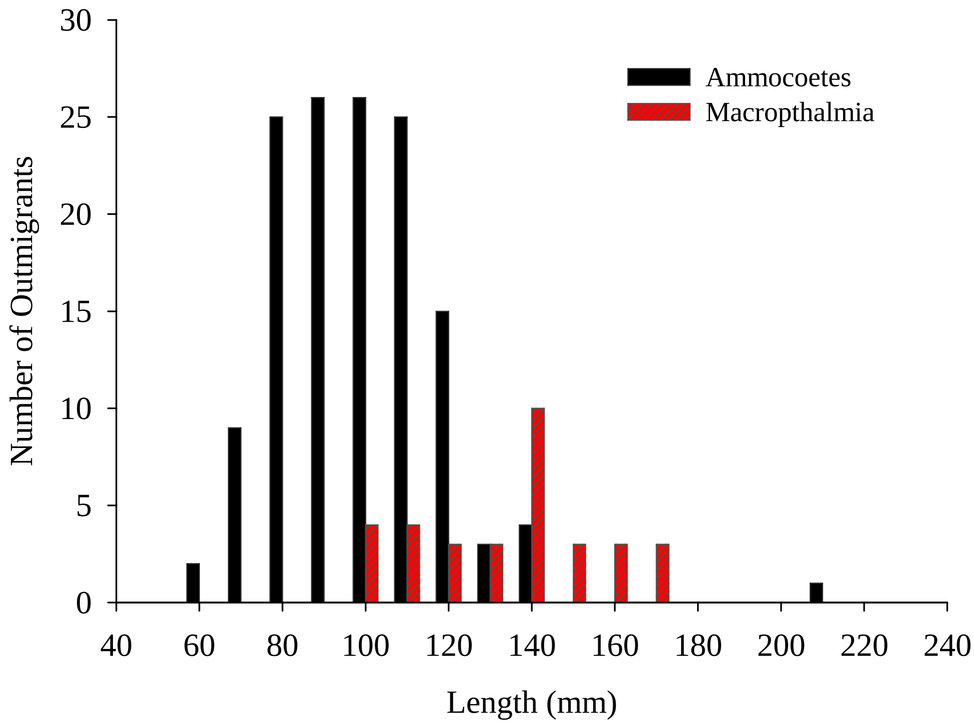

Figure III-2. Length frequency for out-migrants collected in the Warm Springs River rotary screw trap, April 2005 – April 2006.

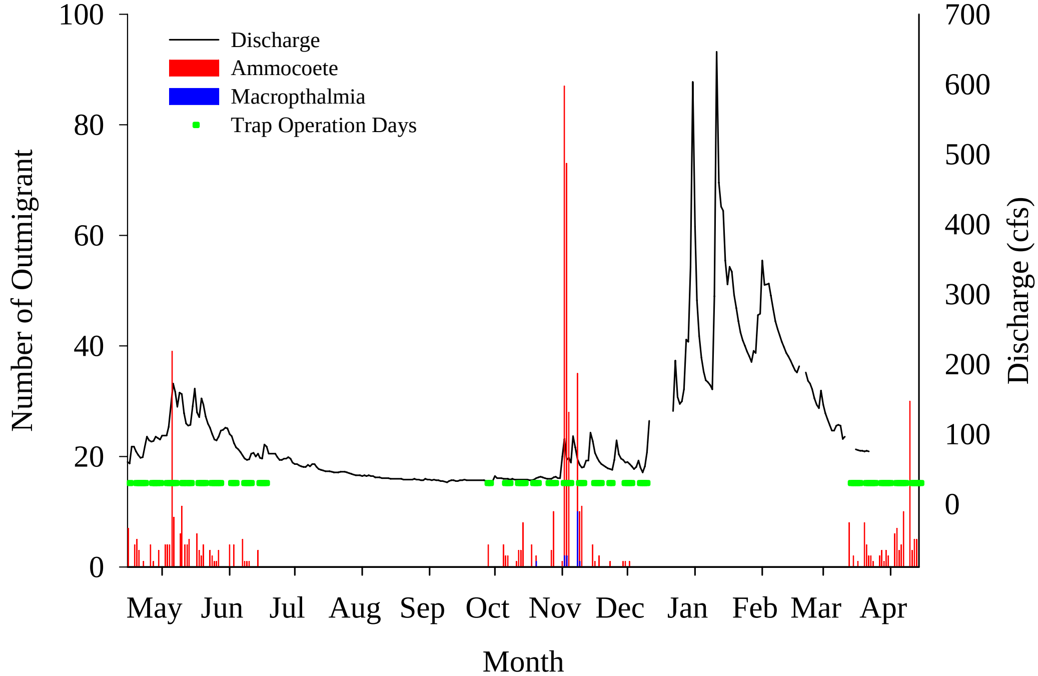

Figure III-3. Out-migration timing for ammocoetes and macropthalmia in Shitike Creek, April 2005 - April 2006.

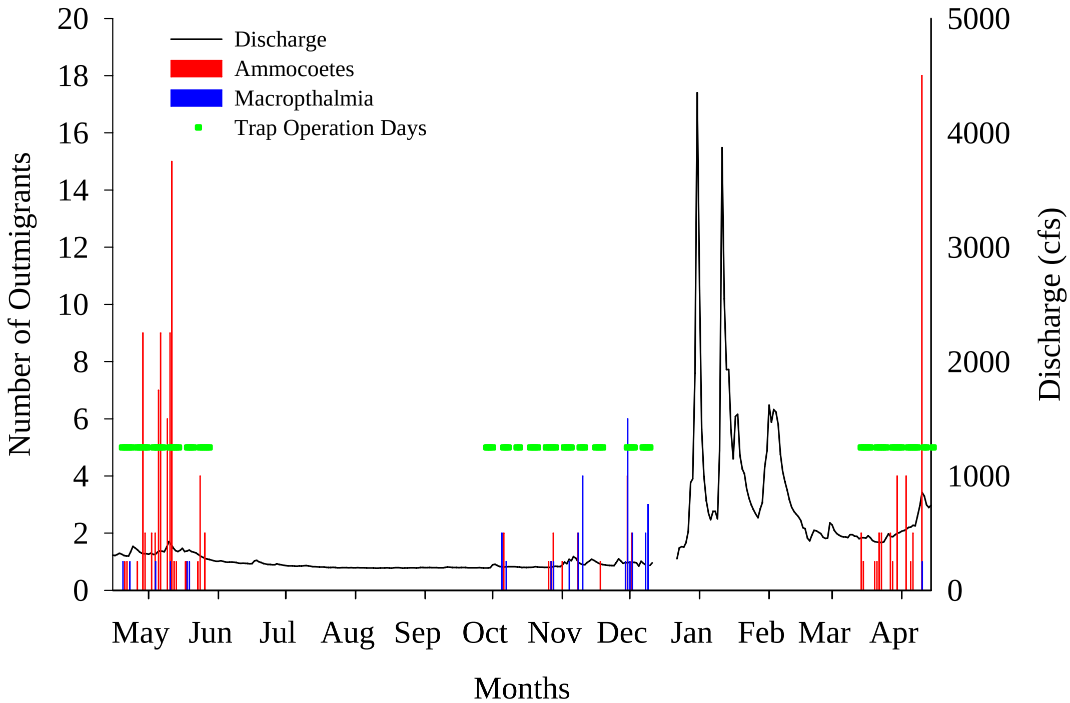

Figure III-4. Out-migration timing for ammocoetes and macropthalmia in the Warm Springs River, April 2005 – April 2006.

SECTION IV
ADULT ESCAPEMENT ESTIMATION AND HARVEST MONITORING

Methods

A systematic approach was developed to collect adult Pacific lamprey using a long-handled dip net at the Sherars Falls fish ladder located at Rkm 71 in the lower Deschutes River (Figure IV-1). Each pool of the fish ladder was dipped once per hour, 4 - 8 hours per night. Dipping occurred in the same location during each sampling event. An elapsed time dipping protocol was used to standardize effort. Sampling occurred 4 randomly selected nights per week from mid June - August.

Captured adult Pacific lamprey were fitted with a floy tag, fin clipped and total length measured. Floy tags were placed approximately 0.5 cm below the mid-dorsal fin area. Sequentially numbered floy tags were used. A fin clip was made at the posterior end of the dorsal fin. Once lamprey had been marked, they were transported approximately 2 Rkm downstream and released into the river. After marking began all lamprey subsequently captured in the fish ladder were inspected for the presence of the primary tag and fin clip. We noted recaptures on data sheets and released them upstream of the fish ladder. We also calculated a primary tag retention rate based on the presence of a fin clip and tag wound.

Abundance of adult Pacific lamprey was estimated using Chapman's modification of the Petersen estimate (Seber 1982). Estimated abundance (*N**) was derived from the equation:

$$N^{*} = \frac{(M + 1)(C + 1)}{(R + 1)} - 1$$

calculated where *M* is number of fish marked in the first sampling event, *C* is the number of fish inspected for marks and *R* is the number of fish inspected for marks in the second event that possess marks applied in event 1.

Figure IV-1. Long-handled dip net used to collected adult lamprey at Sherars Falls, lower Deschutes River, 2005.

Chapman's modified estimate uses a Poisson approximation to the hypergeometric distribution and approaches a minimum variance unbiased estimator of population size with a variance approximated by:

$$V(N^*) = N^2\left(\mu^{-1} + 2\mu^{-2} + 6\mu^{-3}\right)$$

$$\text{where } \mu = MC / N$$

For N* to be a suitable estimate the following assumptions must be met:

1. *All Pacific lamprey have an equal probability of being marked at the Sherars Falls fish ladder;* ***or***
2. *All Pacific lamprey have an equal probability of being inspected for marks;* ***or***
3. *Marked fish mix completely with unmarked fish in the population between sampling events;* ***and***
4. *There is no recruitment to the population between sampling events;* ***and***
5. *There is no sampling-induced behavior or mortality;* ***and***
6. *Fish do not lose their marks and marks are recognizable.*

To determine if we violated assumptions 1 and 2, a Mann-Whitney sum test (alpha = .05) was performed comparing the length distributions between dipnetting and tribal harvest. All Pacific lamprey marked at the Sherars Falls fish ladder were transported and released approximately 2 Rkm downstream allowing them to mix with other upstream migrating lamprey (Assumption 3). Since we tagged throughout majority of the run recruitment into the experimental population should be minimal; therefore assumption 4 was not violated. It is possible lamprey may have entered the experimental population after the completion of the first event sampling. However, we suspended first event sampling when the number of adult Pacific lamprey present in the fish ladder was near zero. Assumption 5 was not violated because there was no direct mortality from dipnetting. While indirect mortality cannot be evaluated we assume it was negligible. Only fish in good condition were marked and released. No deceased, marked lamprey were reported downstream of the first event sampling site during the marking phase of the experiment. We reduced the effect of tag loss (assumption 6) greatly by using a secondary mark. Although some fish lost their primary mark, a secondary fin clip and tag wounds allowed us to determine that the fish had been previously tagged.

In conjunction with the mark-recapture study we conducted a single, access site creel survey to estimate tribal harvest of adult Pacific lamprey at Sherars Falls. We conducted creel interviews during four randomly selected nights per week from mid-June though August. Creel surveys occurred from 9 pm until tribal fisherman completed collection or 3 am, whichever occurred first. Samplers examined all harvested lamprey for marks and recorded total lengths. The number of marked (non-expanded numbers) and unmarked lamprey were recorded on datasheets. Creel numbers were expanded to estimate total harvest and 95% confidence intervals generated.

Total effort and harvest was expanded from each sampling day by:

Total Effort: $$\hat{E} = \sum_{i=1}^{n} (e_i / \pi_i)$$

Total Catch $$\hat{C} = \sum_{i=1}^{n} (c_i / \pi_i)$$

Variance was approximated each sampling week by:

$$Var(\hat{E}_1) \approx N_1^2 Var(\bar{e}_1)$$

Weekly variances were summed to estimate total variance of the harvest estimate.

Study Area

Sherars Falls is located downstream of all perennial tributaries to the Deschutes River at Rkm 71 in the lower Deschutes River (Figure IV-2). A fish ladder around the falls is utilized by upstream migrating adult Pacific lamprey during the summer.

Results and Discussion

Adult Pacific Lamprey Escapement Estimate

We captured a total of 143 adult Pacific lamprey from June 22, 2005 - August 18, 2005. All adult Pacific lamprey collected were in good condition during first event sampling and marked with a numbered Floy tag and fin clip.

We inspected a total of 1,027 adult Pacific lamprey for marks during 2005. Of those, we recaptured 37 (25.87%). Of the 37 recaptured, 5 (13.51%), 14 (37.84%), and 18 (48.65%) were recaptured through long-handled dipnetting, tribal creel, and tribal member tag returns, respectively.

Assumptions 1 and 2, all adult lamprey have an equal probability of being marked or inspected for marks was met. There was no significant difference between the lengths of adult Pacific lamprey marked and those inspected (P = 0.98) (Figure IV-3).

The effects of tags loss were greatly reduced by using multiple marks (assumption 6). All lamprey were tagged with an individually numbered floy tag and fin clip. Tag retention rates were calculated based on the presence of a fin clip and tag wound for adult Pacific lamprey recaptured at Sherars Falls. Of the 37 recaptured, 33 retained their tags (89.19%) (Table IV-1). Based on recaptured fish with number tags, we estimated mean movement rate from Buckhollow Landing to Sherars Falls to be 3.26 days (1.22 – 16.08 days) after marking (Appendix C).

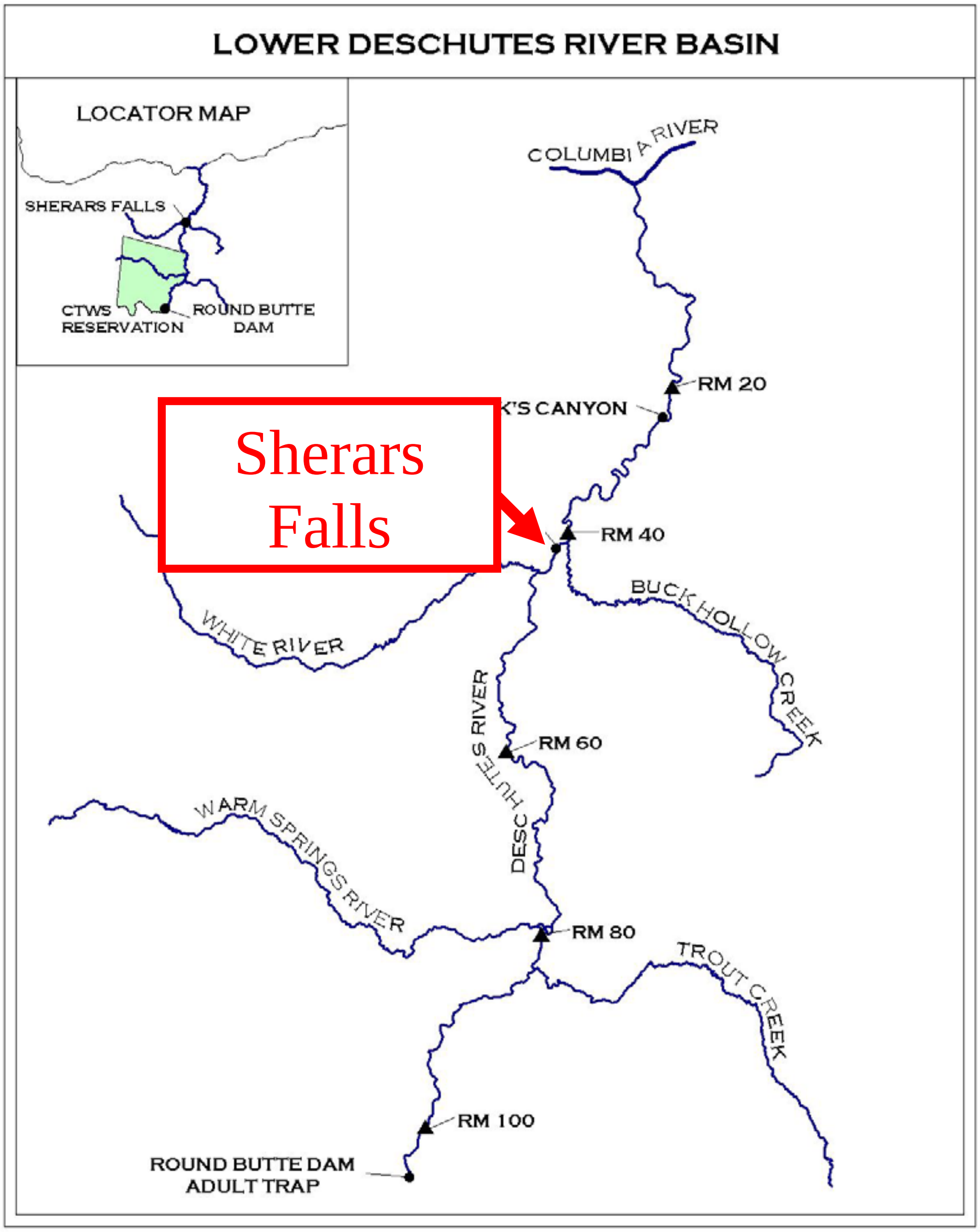

Figure IV-2. Location of Sherars Falls within the lower Deschutes River.

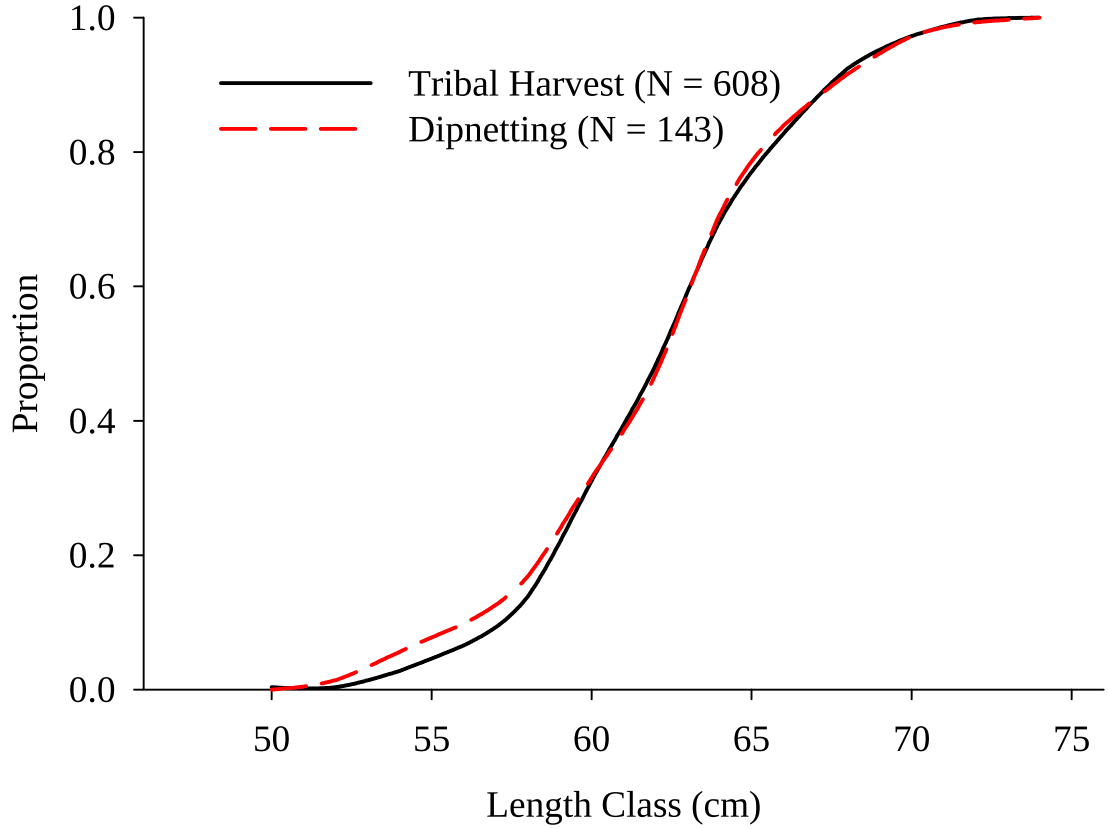

Figure IV-3. Cumulative length frequencies of adult Pacific lamprey marked versus inspected at Sherars Falls, lower Deschutes River, 2005.

Our preliminary population estimate for adult Pacific lamprey in the Deschutes River during 2005 was 3,896 (SE = 525) (Table IV-2). The preliminary estimate of adult Pacific lamprey escapement at Sherars Falls is estimated at 2,881.

Tribal Harvest Monitoring

We conducted a total of 28 creel interviews from June 22, 2005 – August 31, 2005 (Table IV-3). Six-hundred and eight adult Pacific lamprey were inspected and measured. Preliminary estimates of tribal harvest were 1,015 (+/- 74). Based on preliminary population estimates and tribal harvest we estimated an exploitation rate of 26.05%. Descriptive statistics and length frequency histograms can be found in Appendix D.

Table IV-1. Floy tags used to tag adult lamprey at Sherars Falls, lower Deschutes River, 2005.

Tag Type	Picture	Retention
Numbered Floy Tag		89.19%

Table IV-2. Adult Pacific lamprey population estimates in the lower Deschutes River, 2005

Year	No. Tagged	No. Inspected	No. Recoveries	Population Size	Variance	Standard Error	Relative Precision
2005	143	1,027	37	3,896	275,846	525	26.4

Table IV-3. Summary of adult Pacific lamprey tribal harvest creel at Sherars Falls, lower Deschutes River, 2005.

Year	Dates	Interviews Conducted	Lamprey Creeled	Estimated Harvest
2005	6/22-8/31/2005	28	608	1015 +/- 74

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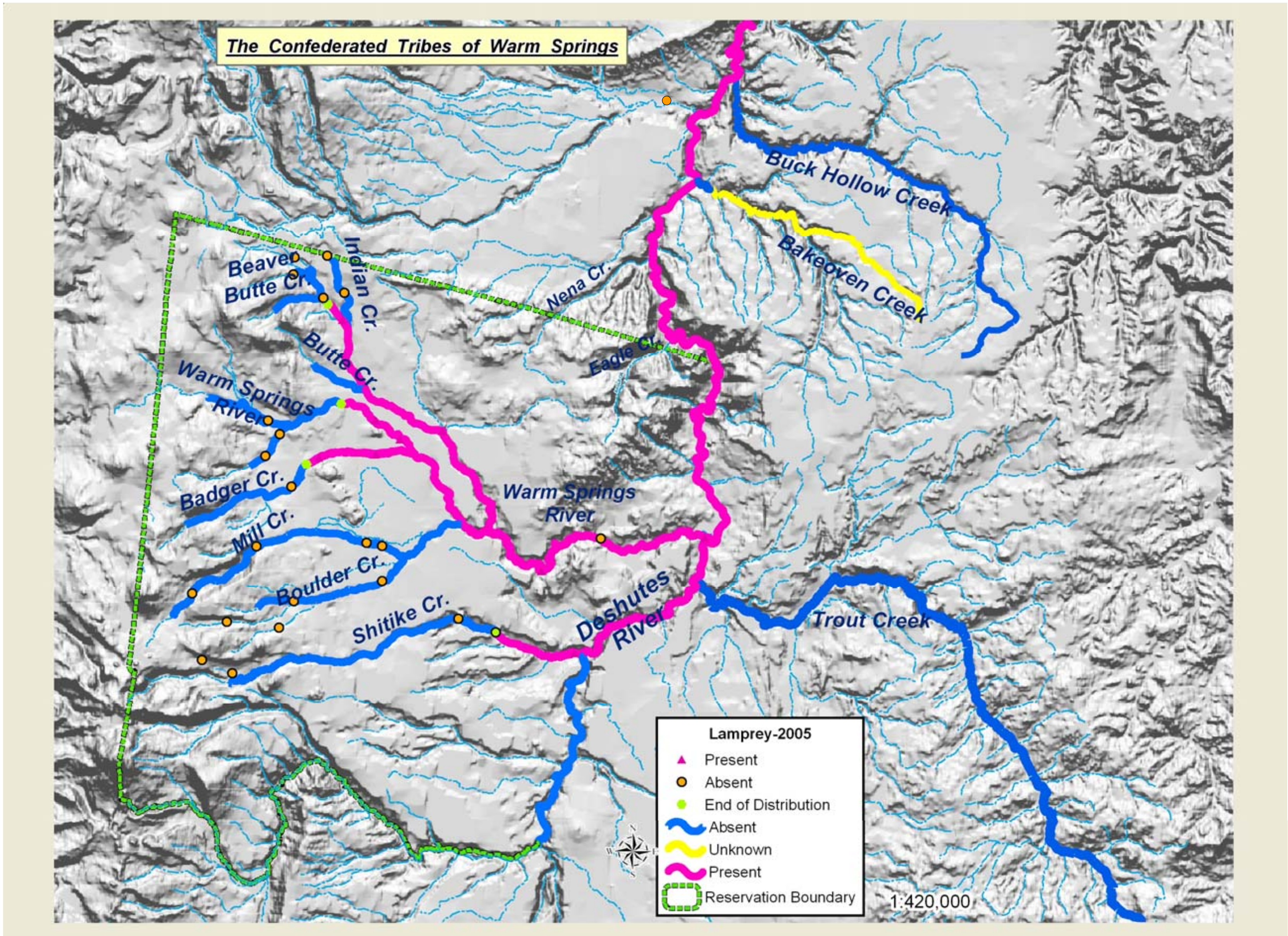
Appendix A

Larval Lamprey Distribution within the lower Deschutes River Subbasin



Appendix A; Figure 1. Ammocoete distribution in the Deschutes River subbasin, 2005.

Appendix B

Out-migrant Lamprey Descriptive for the Shitike Creek and Warm Springs River Rotary Screw Traps April 2005-March 2006

Appendix B; Table 1. Length (cm) statistics for out-migrant lamprey collected in the Shitike Creek rotary screw trap, April 2005 – March 2006.

	Shitike Creek	
	Ammocoetes	Macropthlamia
Sample Size	582	16
Mean Length	111.97	120.63
Standard Deviation	15.70	11.99
Standard Error	0.73	3.0
C.I. Of Mean	6.39	6.39
Max Length	160	142
Min Length	43	94
Median Length	115	121
Skewness	-1.35	-0.51
Kurtosis	3.51	0.97
K-S Distribution	0.16	0.19
K-S Probability	< 0.001	0.11

Appendix B; Table 2. Length (cm) statistics for out-migrant lamprey collected in the Warm Springs River rotary screw trap, April 2005 – March 2006.

	Warm Springs River	
	Ammocoetes	Macropthlamia
Sample Size	138	38
Mean Length	94.12	130.12
Standard Deviation	19.70	20.79
Standard Error	1.69	3.62
C.I. Of Mean	3.34	7.37
Max Length	209	165
Min Length	57	92
Median Length	91.5	133
Skewness	1.54	-0.12
Kurtosis	7.43	-0.96
K-S Distribution	0.06	0.11
K-S Probability	0.18	0.38

Appendix C

Adult Pacific lamprey movement rates from Buckhollow Landing to Sherars Falls

Appendix C; Table 1. Recaptured adult Pacific lamprey movement rates from Buckhollow Landing to Sherars Falls, lower Deschutes River, 2005.

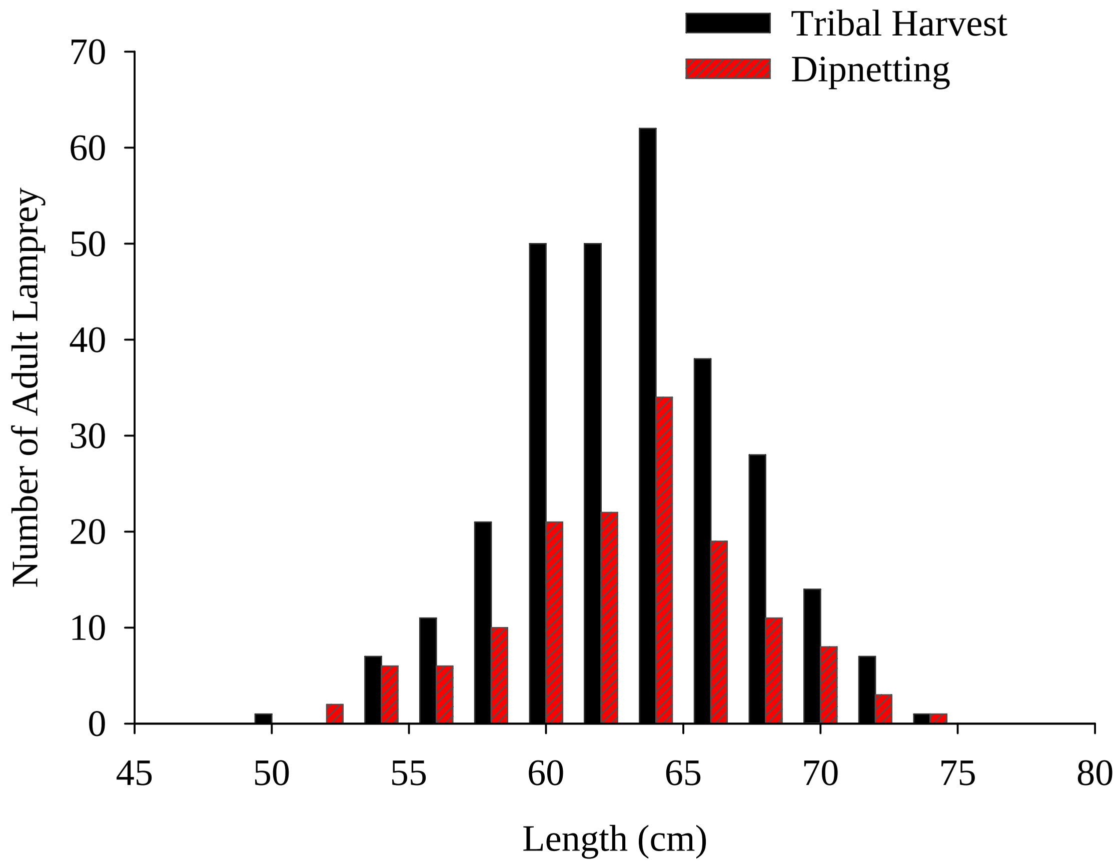
Mark Date	Tag No.	Length (cm)	Girth (mm)	Recapture Date	Days to Return	Movement Rate (Rkm/day)
06/28/05	211	64.0	10.5	07/05/05	7.04	3.52
06/28/05	202	60.0	11.0	06/30/05	2.06	1.03
06/28/05	205	54.0	9.5	06/30/05	2.06	1.03
06/29/05	216	65.5	12.0	07/05/05	6.04	3.02
07/12/05	245	55.0	10.0	07/18/05	6.06	3.03
07/15/05	255	71.0	12.0	07/18/05	3.15	1.57
07/15/05	252	58.0	10.5	07/20/05	5.16	2.58
07/15/05	258	51.0	9.0	07/20/05	5.16	2.58
7/15/2005	256	70.0	11.5	7/26/2005	16.10	8.05
8/11/2005	324	53.0	9.0	8/16/2005	4.98	2.49
08/15/05	328	60.0	10.0	08/31/05	16.00	8.00
08/15/05	326	66.0	10.0	08/31/05	16.03	8.02
8/15/2005	332	62.0	10.0	8/16/2005	0.98	0.49
8/16/2005	338	67.0	10.0	8/18/2005	1.94	0.97
08/17/05	347	64.0	9.5	08/22/05	5.08	2.54
				Max		8.05
				Min		0.49
				Mean		3.26
				Median		2.58

Appendix D

Adult Pacific Lamprey Length Statistics and Frequencies in the lower Deschutes River, at Sherars Falls, 2005.

Appendix D; Table 1. Length (cm) statistics for adult Pacific lamprey collected at Sherars Falls though dipnetting and tribal harvest, 2004-2005.

	Dipnetting	Tribal Harvest
	2005	2005
Sample Size	143.00	290.00
Mean Length (cm)	62.37	62.50
Standard Deviation	4.37	4.04
Standard Error	0.37	0.24
C.I. Of Mean	0.72	0.47
Max Length	73.00	72.50
Min Length	51.00	50.00
Median Length	63.00	62.75
Skewness	-0.20	-0.06
Kurtosis	0.02	-0.19
K-S Distribution	0.07	0.06
K-S Probability	0.10	0.01



Appendix D; Figure 1. Length frequency for adult Pacific lamprey collected through dipnetting and tribal harvest at Sherars Falls, 2005.