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, OREGON, SUBBASIN

2003 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 and it's tributaries is extremely limited. To assess the status of lampreys in the Deschutes River sub-basin, baseline information is needed. In 2003, we completed larval lamprey distribution and habitat surveys in thirteen perennial streams within the lower Deschutes sub-basin. Larval lamprey were found in four streams we surveyed. Lamprey were present in the downstream portions of the streams. Habitat associations were relatively weak but we did find a relationship between lamprey presence and wood (P=0.0) and depositional area (P=0.01). Rotary screw traps were used to determine out-migration timing in the Warm Springs River and Shitike Creek. Outmigrant numbers were not estimated due to a lack in trap efficiency. In 2002, ammocoetes and macropthalmia outmigrated in March while in 2003, peak out-migrantion varied by developmental stage and stream. We conducted a feasibility study in the mainstem Deschutes River (Rkm 71) to determine if adult escapement could be estimated using mark-recapture methods. Using a long-handled dip net, 199 adult lamprey were collected. All lamprey were fitted with a floy tag, fin clipped, total length measured and released downstream 2 Rkm. We recaptured 35 through dipnetting and a tribal lamprey creel. Tag retention was estimated to be to be 71% based on the presence of a tag wound and fin clip. We also conducted a tribal creel to estimate the number of lamprey collected by Confederated Tribes of Warm Springs tribal members. Twenty-one interviews were conducted with tribal members and we estimated harvest at close to 1,000 adult Pacific lamprey.

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Introduction

There are three species of lampreys endemic to the Columbia River Basin (CRB). Two of which, Pacific lampreys and river lampreys, are anadromous (Beamish 1980). The third, western brook lamprey, completes it's lifecycle in freshwater. Little information is available on the distribution and abundance of river lampreys or western brook lampreys 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 some life history information is available on Pacific lampreys there are many critical uncertainties (Beamish 1980; Beamish and Levings 1991; Close et al. 1995; Pletcher 1963; Scott and Crossman 1973; van de Wetering 1998). Currently multiple projects are underway in the CRB trying address some of these uncertainties (Bayer et al. 2000a; 2000b; 2001; 2002; Close et al. 1995; Close 1998; 1999; 2000; 2001; Cochnauer, T. and C. Claire 2000; Jackson et al. 1996; 1997; Stone et al. 2000; 2001; 2002).

Pacific lampreys 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. Dam counts through the CRB have been used to assess decreasing trends in upstream migrating Pacific lamprey (Kostow 2002). In 1993, the state of Oregon listed Pacific lampreys 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 lampreys. 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. 2001). 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 lampreys has been underestimated (Close et al. 1995; CRITFC 1995; Kan 1975). For the Native American tribes of the Pacific Coast, Pacific lampreys are an important subsistence, ceremonial, and medicinal resource (Close et al. 1995; 2002; CRITFC 1995; Hunn and Selam 1991; Pletcher 1963). The people of Confederated Tribes of Warm Springs Reservation, Oregon (CTWSRO) harvest Pacific lampreys at Sherar's Falls in the lower Deschutes River sub-basin. Lack of sufficient numbers of Pacific lampreys for cultural needs have forced tribal harvesters to collect lampreys at alternate spots including Willamette Falls, on the Willamette River, located in Oregon City, Oregon and at Savage Rapids, on the Rogue River, located near Grants Pass, 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 larval distribution and associated habitats in the lower Deschutes River sub-basin; (2) determine species composition in the lower Deschutes sub-basin; (3) estimate the number of lamprey emigrants, by developmental stage, from Warm Springs River and Shitike Creek; and (4) evaluate the feasibility of conducting a mark-recapture study to estimate the escapement of adult lampreys over Sherars Falls and estimate the lampreys harvest at Sherar's Falls.

Project Area

The lower Deschutes River sub-basin 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 to the lower Deschutes River originate within the Confederated Tribes of Warm Springs Reservation. The reservation covers 260,000 ha. on the eastern slopes of the Cascade Mountains. The Reservation boundaries run from the crest of the Cascades to the north and west, the Deschutes River to the east and the Metolius River to the south. The Warm Springs River is the largest river system within the Reservation. The river flows for 85 kilometers and drains 54,394 hectares. It is the largest tributary to the lower Deschutes River. Major tributaries to the Warm Springs River include Beaver Creek and Mill Creek. Shitike Creek is the third largest tributary to the lower Deschutes River. It flows for 48 km and drains 36,000 hectares.

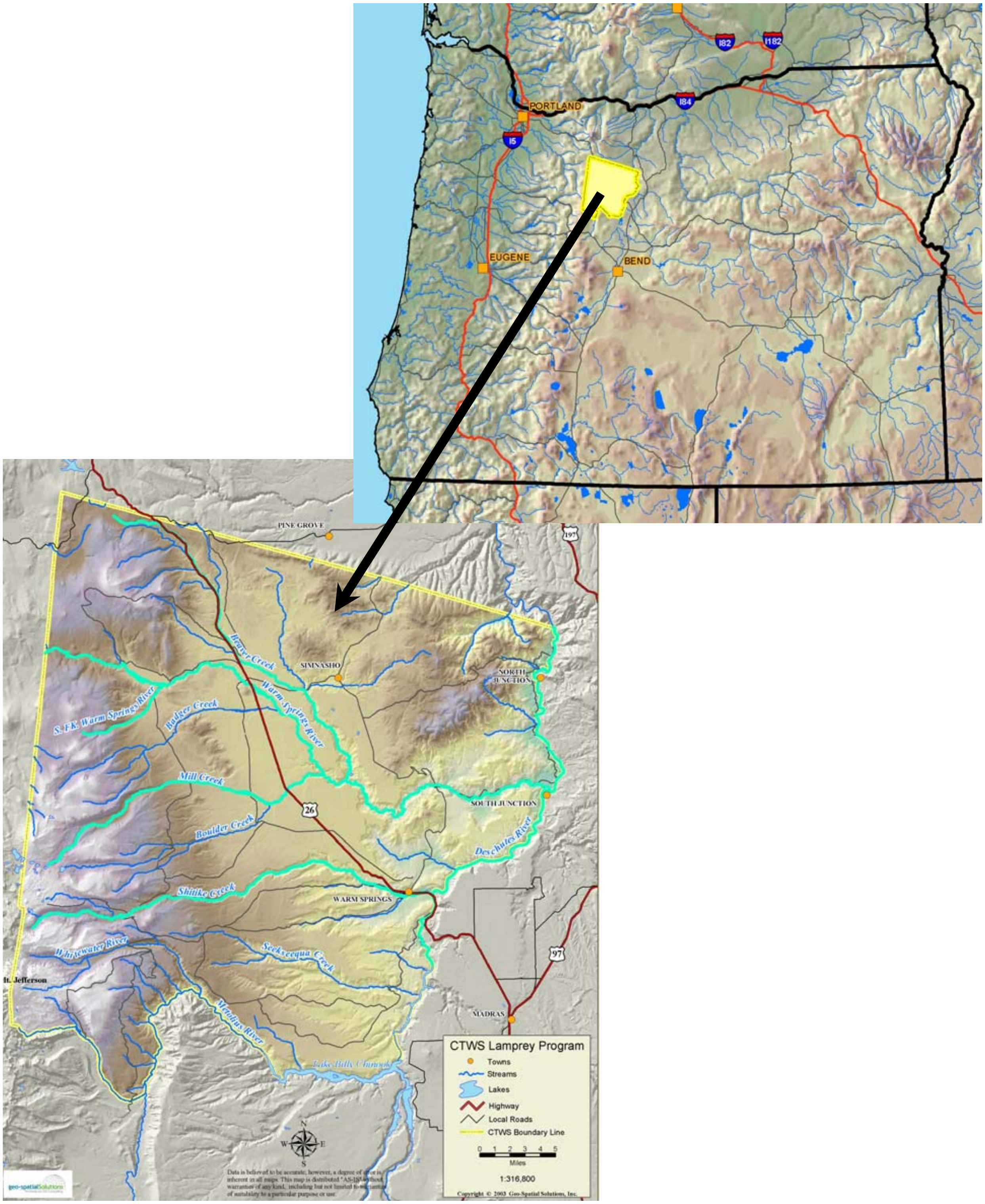

Figure 1. Map of Oregon showing the location of the Confederated Tribes of Warm Springs Reservation, Oregon.

Section I
Larval Distribution and Habitat Associations

Methods

Larval lamprey distribution and habitat association surveys were conducted from May – August 2003, in perennial tributaries to the lower Deschutes River. A hierarchical random stratified sampling design was used. The sampling design was developed and successfully utilized by Torgersen and Close (2000) to document larval lamprey distribution in the John Day sub-basin. The sampling methodology consists of three tiers: Level I-stream reach, Level II-transect and Level III-sub-sample (Figure I-1).

Level I Stream Reach: Perennial streams were divided into 10 km 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. The location of each sample reach was recorded with Global Position System (GPS) equipment.

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

Level III Transect Sub-samples: Two sub-samples were surveyed along each Level II transect. Each sub-sample was randomly located along the transect. The sub-sample consisted of a one square meter sampling area. Where the stream was less than 3 m wide (wetted channel width) the 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 larval lamprey within each Level III sub-sample. The unit is specifically designed to capture larval lamprey (O'Neal 1987). The shockers delivered a constant 125 V at a rate of 3 pulses/s with a pulse train of 3:1 (Pajo and Weise 1994). Two electrofishing passes of 90 seconds were applied to each sub-sample. Captured lamprey were anesthetized with MS-222 and measured for length to the nearest mm and weighed to the nearest $1/10^{th}$ gram. *Lampetra* species were identified (refer to objective 2). Fish were released at the sampling point after recovering from anesthesia. All other species captured during electrofishing were enumerated and recorded.

Habitat and water chemistry data was collected at level I, II and III tiers. The habitat and water chemistry data recorded at each tier is displayed in table I-1.

Associations of larval lamprey presence with physical habitat characteristics will be analyzed using multiple logistic regression and multivariate analysis of habitat variables. A GIS map was generated to displaying the distribution of larval lamprey within the surveyed streams.

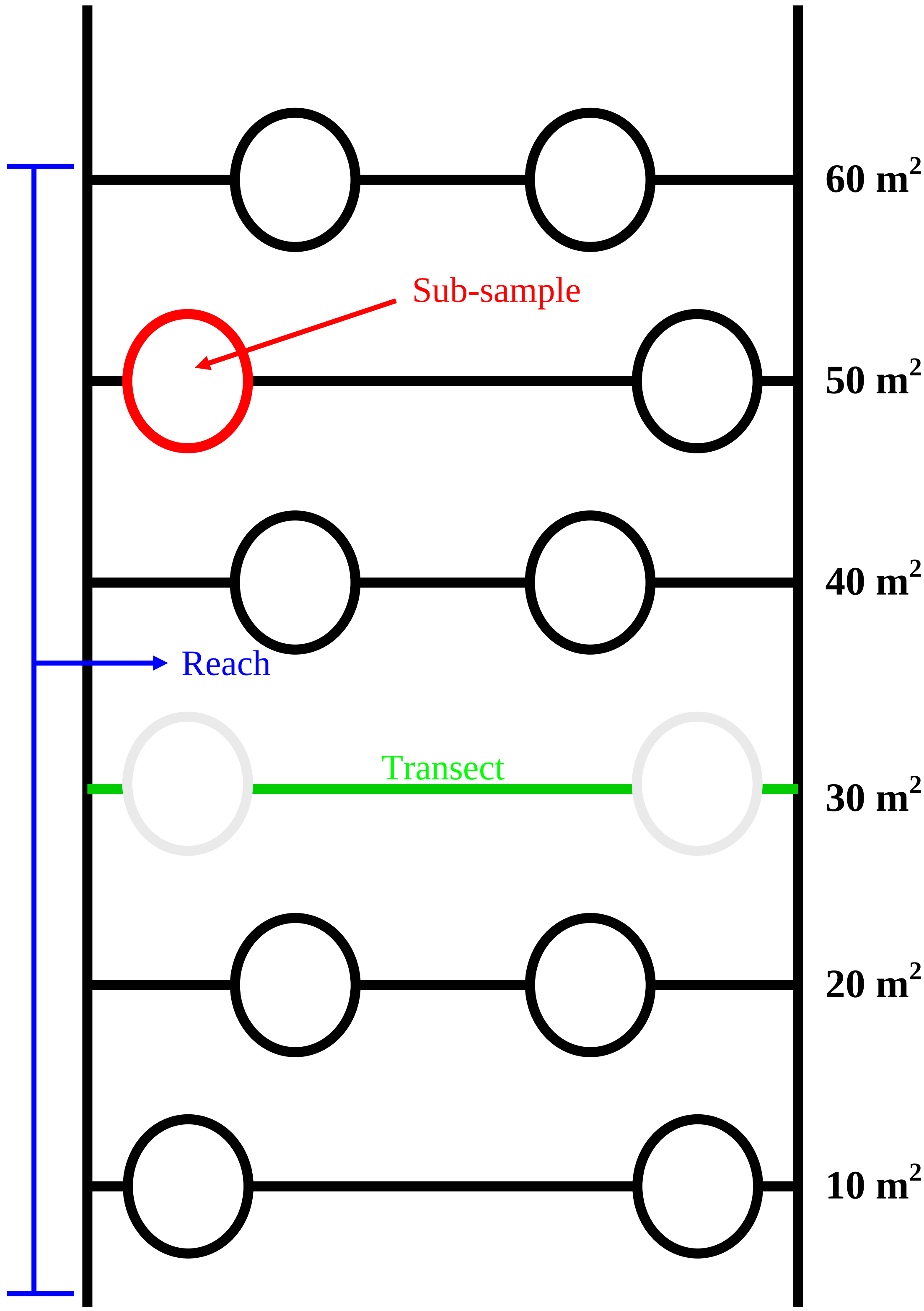

Figure I-1. Diagram of hierarchical random stratified sampling design used in the lower Deschutes River sub-basin, 2003.

Table I-1. Habitat and water quality data to be collected at each sampling tier.

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

Results and Discussion

We sampled 13 perennial streams during 2003 and larval lamprey were present in four (Figure I-2). A list of the streams sampled can be found in table I-2. Larval lampreys were only present in low gradient areas in the lower reaches of the four streams. Larval lamprey distribution has been confined to the lower reaches of tributary streams in other basins (Richards 1980).

The distribution of lamprey may have ended due to the energetic costs of upstream migration prior to spawning. In Shitike Creek, less than 10 Rkm from the confluence with the Deschutes River, larval lamprey distribution ended. At this point, the gradient, substrate size, and flow increased. No larval lamprey were present in Mill Creek which has similar habitat characteristics (high gradient, larger substrate, higher flows) to Shitike Creek near it's confluence with the Warm Springs River.

Within the lamprey distribution, 132 sub-samples were completed. Of those, 39 (29.55%) contained lamprey. The number of larval lamprey collected at each site was highly variable. The maximum, minimum, and mean number of larval lamprey per sub-sample was 19, 0, and 0.99, respectively. We collected 131 larval lamprey ranging in size from 25 mm – 145 mm with a mean length of 77 mm. The mean weight of all larval lamprey collected was 1.29 g with a range of 0.1 g – 4.7 g.

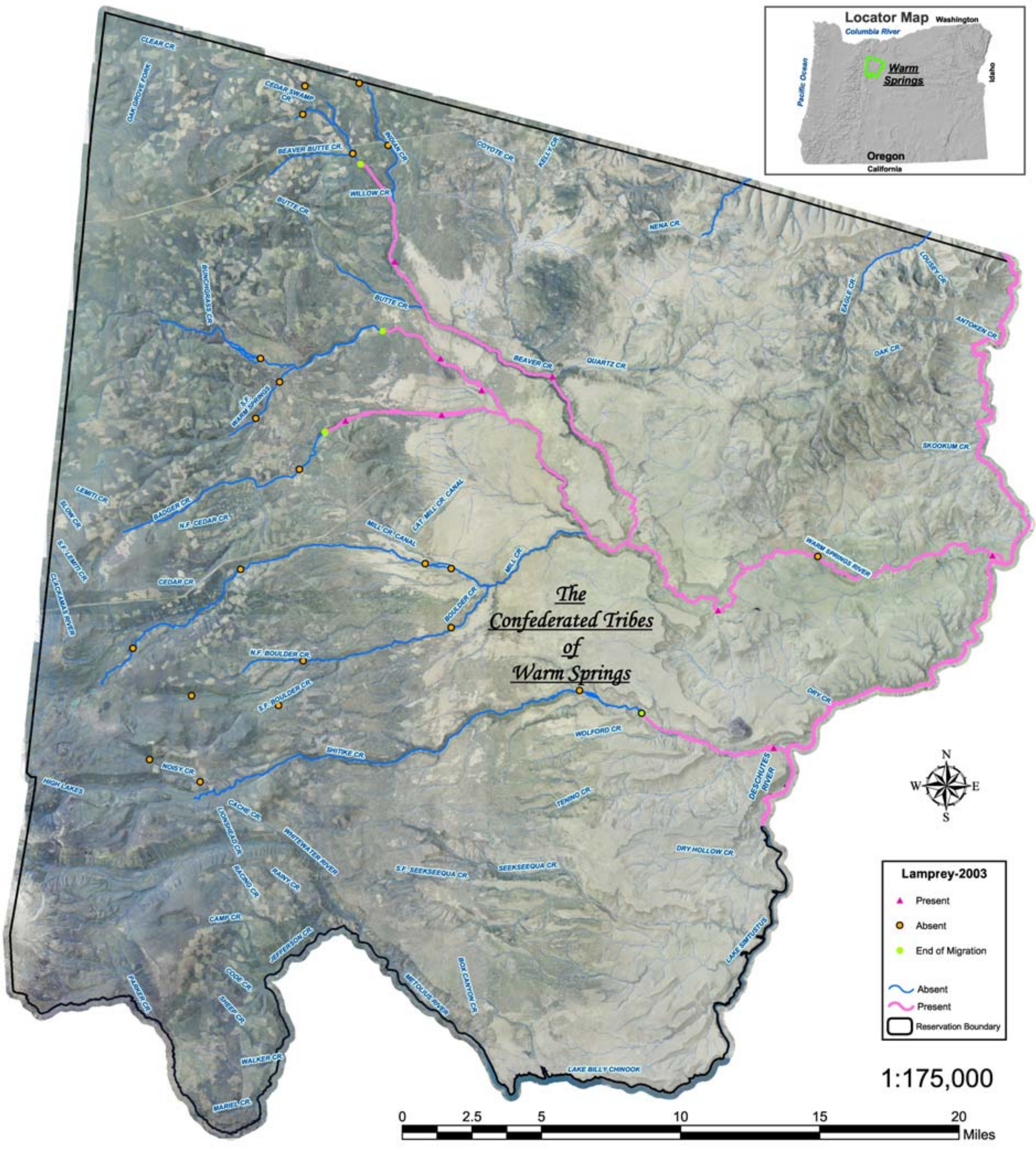

Figure I-1. Ammocoete distribution within the lower Deschutes River subbasin, 2003.

Table I-2. Streams, number of reaches and larval lamprey presence during larval distribution surveys in the lower Deschutes River subbasin, 2003.

Stream	Reachs Sampled	Larval Lamprey (Present/Absent)
Badger Creek	3	Present
Beaver Creek	4	Present
Beaver-Butte Creek	1	Absent
Boulder Creek	2	Absent
Indian Creek	2	Absent
Mill Creek	4	Absent
N. Boulder Creek	1	Absent
Noisy Creek	2	Absent
S. Boulder Creek	1	Absent
S. Fork Warm Springs River	2	Absent
Shitike Creek	3	Present
Wilson Creek	1	Absent
Warm Springs River	6	Present

Due to low sample sizes it was difficult to find any habitat relationships with larval lamprey presence. Although relatively weak we did see a positive relationship with larval lamprey presence and wood (P=0.00). We also found that depositional area (P=0.01) may be an indicator of lamprey presence. Woody debris was not classified by size category (diameter breast height or length), only by presence or absence. Depositional area was characterized by the presence of soft substrate (silt or sand), generally containing large amounts of organic debris and located near stream margin. When woody debris and depositional area were present in a sub-sample, 100% of the time lamprey were present.

Water habitat was classified into four categories: alcove, glide, pool and fast water (including riffles, cascades, etc.). Within the larval lamprey distribution the majority of our sampling was conducted in riffles (59.09%) followed by alcoves (18.18%), pools (12.12%), and glides (10.61%). Larval lamprey were present 71.43% of the time in glides followed by 62.50% in pools, 45.83% in alcoves and 21.79% in riffles.

Sampling in 2004 should allow us to increase the total number of samples completed, allowing us to strengthen or find new relationships with lamprey presence and physical habitat relationships.

Section II
Determine 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 larval lamprey in the field is problematic due to similar morphologies (Richards 1980, Bond 1979).

During larval 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 larval lamprey were abundant sub-samples of lamprey were collected in stage A, 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.

Problematic specimens were analyzed by personnel from the USGS-Columbia River Research Laboratory (CRRL) familiar with larval lamprey species identification. Specimens of known species will be placed in a permanent collection to aid in species identification during future field surveys.

Results and Discussion

In 2003, we identified Pacific lamprey in two life phases: juvenile lamprey outmigrants and adult. Outmigrants were identified in the Shitike Creek and Warm Springs River screw trap. Adult Pacific lamprey were identified at Sherar's Falls during the summer upstream migration.

No western brook or river lampreys were identified during larval distribution surveys in 2004.

Due to the low numbers of larval lampreys encountered during the distribution surveys only three unidentifiable specimens were collected for lab identification. All three specimens were identified as stage A Pacific lamprey. No samples were collected from the rotary screw traps in 2003.

Section III
Estimate the Number of Lamprey Emigrants

Methods

We fished a 1.5 m cone diameter floating rotary screw trap in Shitike Creek (Rkm 1.2). The Shitike Creek trap was fished from April through July 2003, September through December 2003, and March 2004. We also fished a floating rotary screw trap with a 2.4 m cone diameter at Rkm 1.5 in the Warm Springs River to collect lampreys from April through June 2003, September through December 2003, and March 2004. We operated both traps 5 days/week, 24 hrs/day. Each trap was 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 lampreys were anesthetized with MS-222, identified to species, stage of metamorphosis, total lengths measured and checked for anomalies. After recovery from anesthesia the lampreys were released below the trap site.

River flows were monitored at USGS gaging stations located near the Shitike Creek (USGS gaging station 14093000) and Warm Springs River (USGS gaging station 14097100) rotary screw traps 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.

Trap efficiencies were conducted on both the Warm Springs River and Shitike Creek rotary screw traps three times from April 2003 – December 2003. Lampreys were collected using a backpack electrofisher. Collected lampreys were anesthetized, measured for total length, weight, marked with elastomer dye and placed in the trap holding boxes for 24 hours. Multiple size classes were collected for each trap efficiency to determine size selectivity. At the end of the 24 hour period, lamprey were recollected from the holding boxes and the number of lamprey with elastomer marks were recorded on data sheets.

Results and Discussion

Shitike Creek

2002-2003

Lampreys were present 72.8% of the time the rotary screw trap was fished in Shitike Creek. We collected 764 lampreys ranging in length from 21 mm – 156 mm with a mean length of 104 mm. Ammocoetes made up more than 99% of the total catch. Lampreys were present in trap catches each month the traps were operated except for October 2002.

Warm Springs River

2002-2003

Lampreys were present in the Warm Springs rotary screw trap 73.5% of the time the trap was fished. We collected 293 lampreys and 79% were identified as Pacific lampreys. Ammoceotes made up the greatest proportion of the catch (.80). The maximum, minimum and mean length of lamprey collected was 135 mm, 12 mm, and 80 mm.

Overall Catch

2002-2004

Since April 2002, we have collected 1,643 lampreys in Shitike Creek and Warm Springs River rotary screw traps. Sixty-nine percent of lampreys were collected in Shitike Creek and the remaining (32%) in the Warm Springs River. Of the 1,643 lampreys collected, 68% were identified as Pacific lamprey. Thirty-two percent were unidentified lampreys. Unidentified lampreys were collected prior to identification training in October 2002.

Shitike Creek

2003-2004

Lampreys were collected 84 of the 112 days the rotary screw trap was fished in Shitike Creek (Appendix A). We collected 491 lampreys in the Shitike Creek trap and all were identified as Pacific lampreys. Ammocoetes made up over 99% of the total catch.

The maximum, minimum and mean length of lampreys collected in the Shitike Creek trap was 147 mm, 44 mm and 98 mm, respectively. The length frequency for ammocoetes in Shitike Creek can be found in Figure III-1. As in 2002, we observe the mean length of ammocoetes in the Shitike Creek trap to be larger than the mean lengths of ammocoetes collected in the Warm Springs River (Appendix B). Ammocoete mean lengths were similar to those of macropthalmia collected in the Warm Springs River trap. Macropthalmia may not be present in the Shitike Creek trap because they are moving into the mainstem Deschutes prior completing their metomorphosis.

Because of small sample size (N=1) macropthalmia were included with ammocoetes to determine peak movement time. We observed peak movement during December of 2003, when the CPUE was 13.75 lampreys/day (Figure III-2). Lampreys were collected during each month the traps were fished except September 2003.

Warm Springs River

2003-2004

Lampreys were present in the Warm Springs rotary screw trap 81 of 118 days the trap was fished (Appendix A). We collected a total of 336 Pacific lampreys. Macropthalmia made up 26% of the total catch.

The maximum, minimum and mean length of Pacific lamprey ammocoetes collected in the Warm Springs River trap was 136 mm, 49 mm and 84 mm. Pacific lamprey macropthalmia lengths ranged from 90 mm – 159 mm with a mean of 125 mm. Length frequencies for ammocoetes and macropthlamia can be found in Figure III-3.

Peak out-migration timing for macropthalmia and ammocoetes in the Warm Springs River was during March 2004 (Figure III-4; Figure III-5). Data is currently not available to compare out-migrant movement to river discharge. Out-migration timing varied by year and lamprey developmental stage. We found no relationship between river discharge and the number of lamprey out-migrating in the Warm Springs River during 2002-2003.

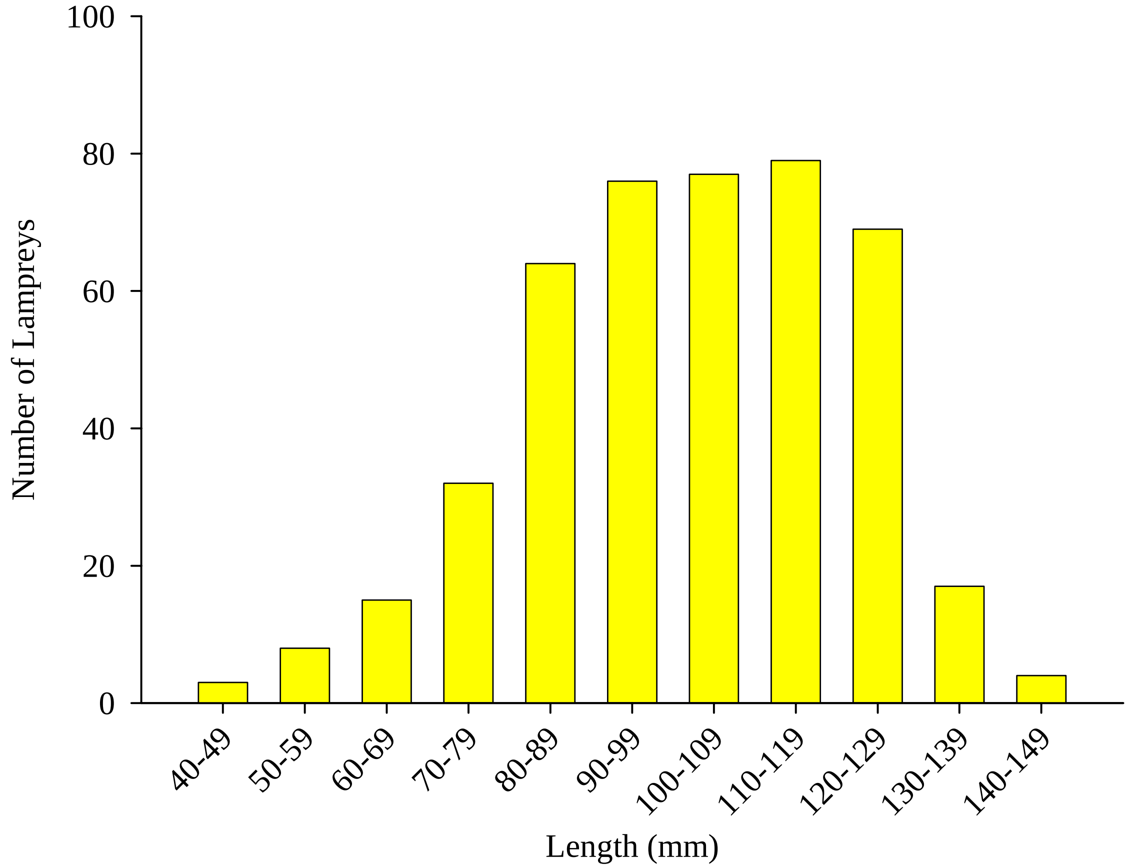

Figure III-1. Ammocoete and macropthalmia length frequency in Shitike Creek, April 2003-March 2004.

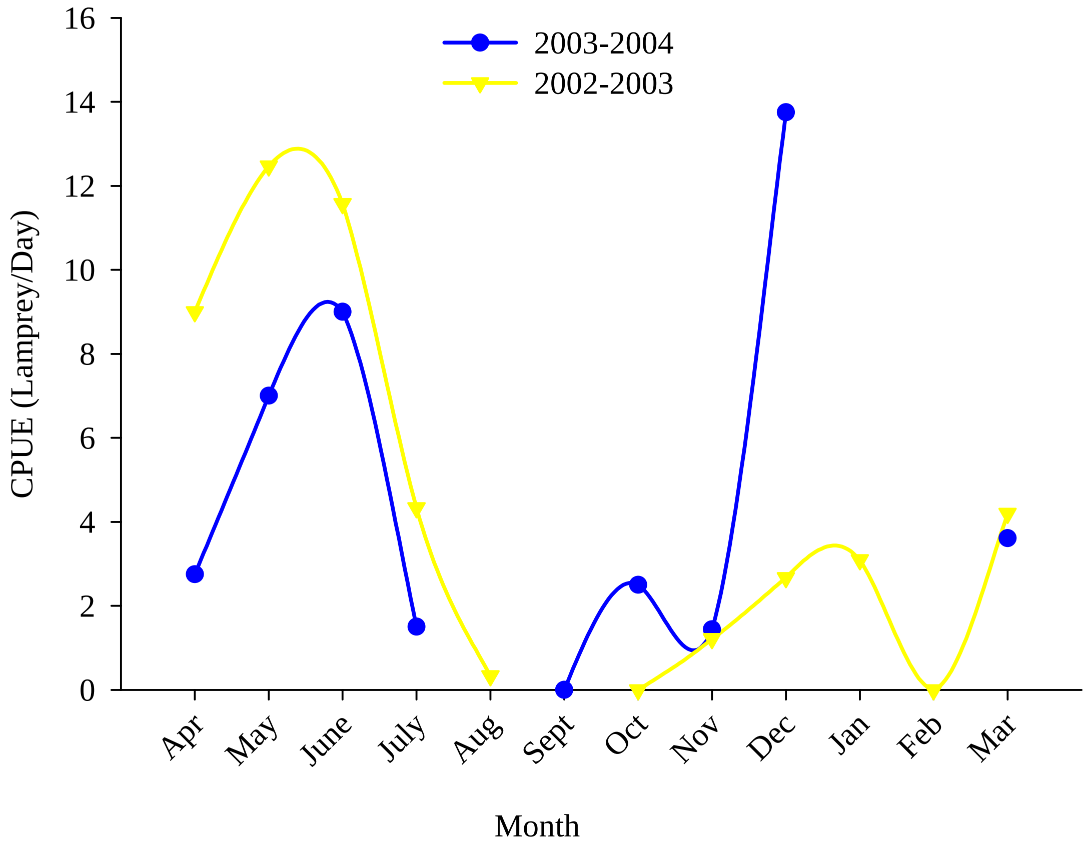

Figure III-2. Out-migration timing for ammocoetes and macropthalmia in Shitike Creek, April 2003 - March 2004.

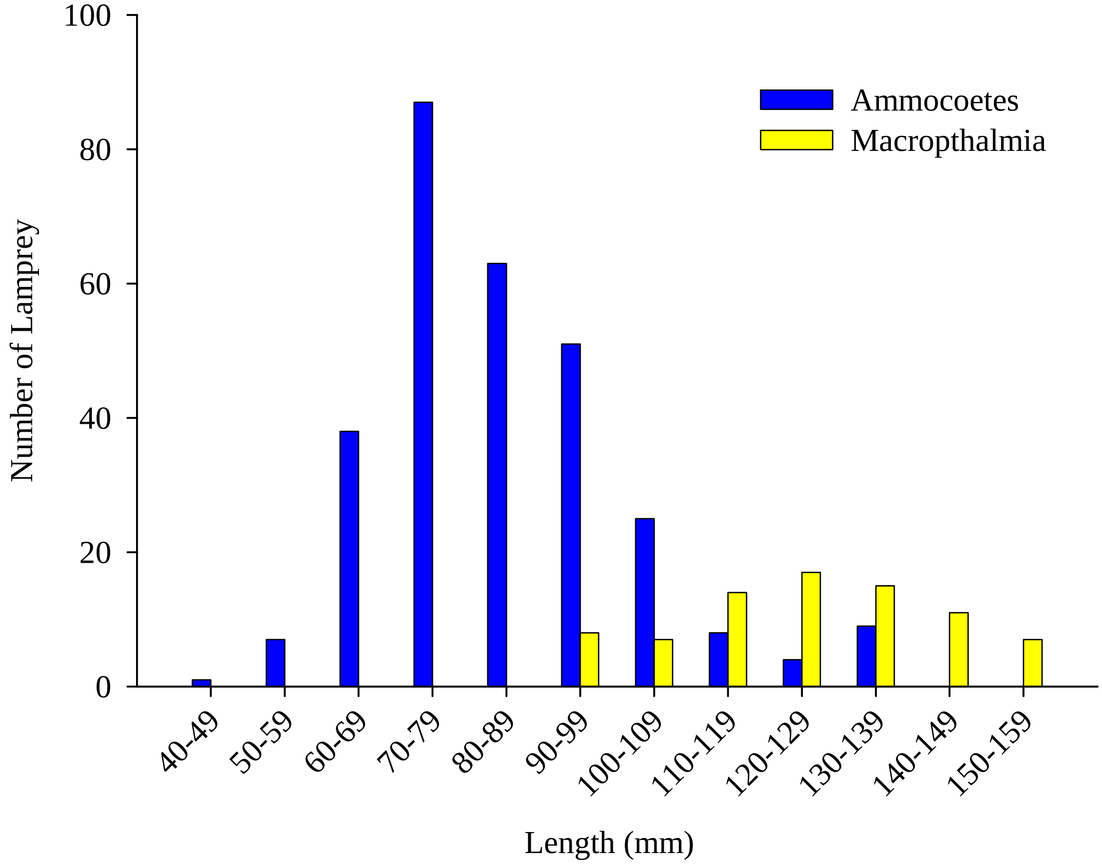

Figure III-3. Length frequency for ammocoetes and macropthalmia in the Warm Springs River, April 2003-March 2004.

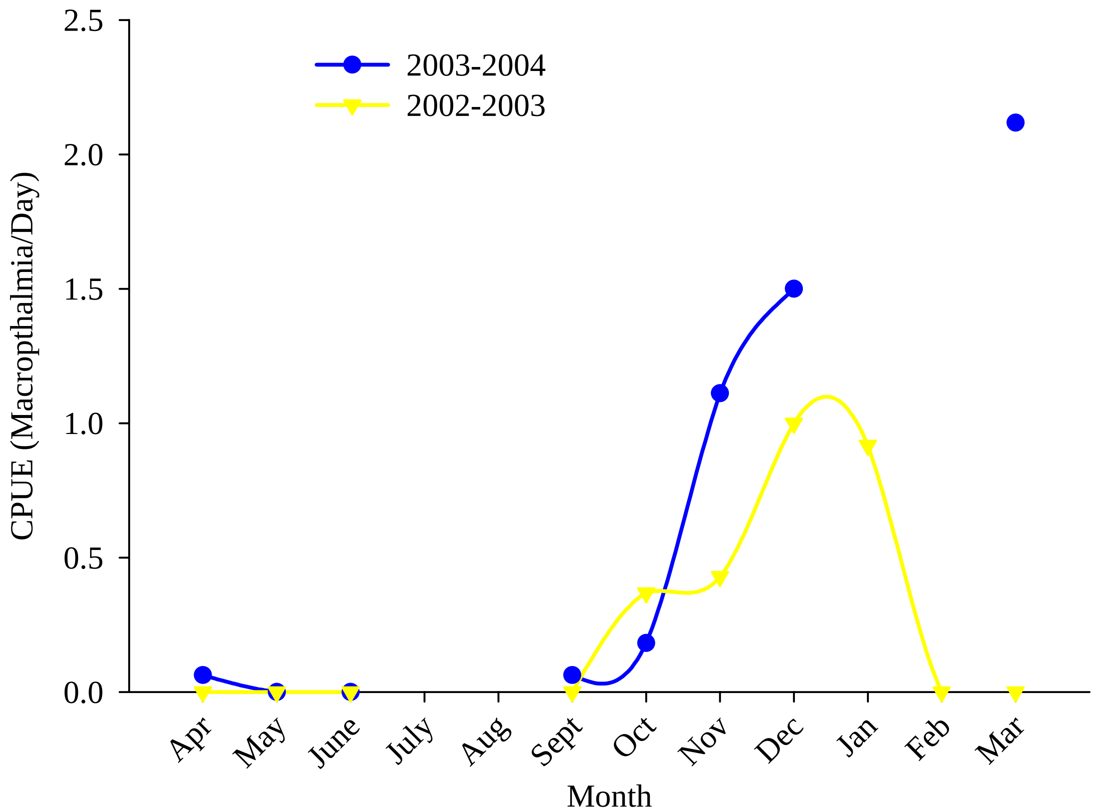

Figure III-4. Out-migration timing for macropthalmia in the Warm Springs River, April 2003-March 2004.

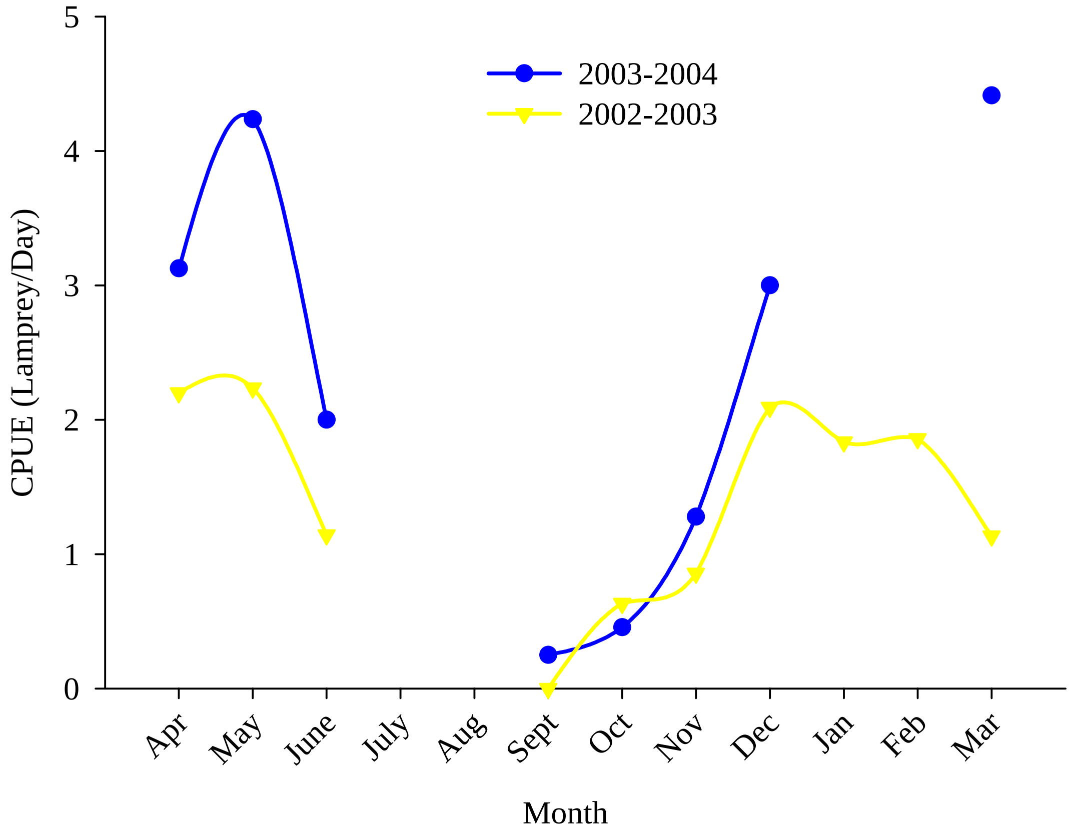

Figure III-5. Out-migration timing for ammocoetes in the Warm Springs River, April 2003 – March 2004.

Trap Holding Efficiencies

We conducted multiple trap holding efficiencies in Shitike Creek and Warm Springs River. In all cases, our holding efficiencies were zero. We will attempt to correct this by making modification to the current traps and conducting further trials during 2004. The number of out-migrants could not be estimated this year due to the lack of trap holding efficiency.

Section IV
Adult Escapement Estimate and Adult Lamprey Harvest Monitoring

Methods

Live traps and a long-handled dip net were used to collect adult lamprey for first and second event sampling.

Live traps designed by USFWS in Vancouver were fished from the end of June through early- July (Figure IV-1). The traps were constructed from 25 cm diameter sewer pipe 95 cm in length. Funnels were attached to each end. A 5 cm diameter entrance point was cut into each of the funnels. We experimented with multiple modifications to the original trap design including smaller diameter pipe, multiple lengths of PVC and using fine mesh screening on one end rather than funnels (Table IV-I). Traps were also colored to match the fish ladder environment. Due to lack of anchoring areas, live traps were only fished at the top and bottom of the fish ladder.

A systematic approach was developed to collect adult Pacific lamprey using a long-handled dip net at the Sherar's Falls fish ladder. Netting occurred from late June through the end of August. We dipped each pool of the fish ladder once per hour for 4 - 8 hours per night, during 2 randomly selected nights per week. Dipping occurred in the same location during each sampling period. We used an elapsed time dipping protocol to standardize effort.

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. Both sequentially numbered and colored 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.

In conjunction with the mark-recapture feasibility study we conducted a single access site creel survey to estimate tribal harvest of adult Pacific lamprey at Sherar's Falls. Creeling began during mid-June and continued though August. The creel was stratified by weekday (Sunday at 12:01 am through Friday at 12:00 am) and weekend (Friday 12:01 am through Saturday 12:00 am). Four weekdays and one weekend were randomly selected per week. Creel surveys occurred from an hour after sunset to 03:00 am. Samplers examined all harvested lamprey for marks and recorded total lengths. The number of marked (non-expanded numbers) and

Figure IV-1. Photo of "lamprey pot" designed by USFWS to collect adult Pacific lamprey, 2003.

Table IV-1. Trap dimensions for mark-recapture feasibility work at Sherar's Falls, 2003.

Trap Number	Sewer Pipe Diameter (cm)	End Type*	Length (cm)
2	6	f,f	90
3	12	f,f	95
4	12	f,m	48
6	6	f,m	90
7	8	f,m	90

*f=funnel; m=mesh

unmarked lamprey were recorded on datasheets. A harvest estimate was generated with 95% confidence intervals.

When sampling was not scheduled and no tribal harvest occurred, lamprey present in the fish ladder were enumerated hourly to estimate peak movement times throughout the night.

Results and Discussion

Adult Escapement Estimate

Live traps were fished for a total of 6,424 minutes at the top and bottom of the fish ladder. Time fished ranged from 70 - 1,915 minutes with an average of 642.4 minutes. No adult Pacific lampreys were captured despite their presence in the ladder when the traps were fished. High water velocities and difficulties in anchoring the traps prevented us from fishing the traps in different locations in the fish ladder and within the ladder cells. Trapping of upstream migrating adult Pacific lamprey has been relatively unsuccessful in the CRB with the exception of a live trap fished at Bonneville Dam by NOAA Fisheries (Aronsuu et al. 2002; Moser et al. 2002; Ocker et al. 2001; Stone et al. 2000; 2001; 2002; Vella et al. 1999; Vella et al. 2001). Field observations were made of lamprey ascending and moving along the top of the cells within the fish ladder rather than suctioning to the rocks walls bordering the ladder cells. We believe the traps were not effective because they were fished along the rock walls.

We collected 199 adult Pacific lamprey with of a long-handled dip net between 30 July and 19 August 2003. Catch rates varied from 21.82 - 52.97 adult Pacific lamprey/hour (Table IV-2).

The maximum, minimum, and average lengths for adult Pacific lamprey were 73 cm, 51 cm, and 61.9 cm, respectively (Appendix C). Length frequencies were calculated for lamprey collected during the mark-recapture feasibility study (Figure IV-2).

All captured adult Pacific lamprey were tagged and received a fin clip. A total of 35 adult lampreys were recaptured. Eleven lampreys were recaptured during subsequent first event sampling. During the tribal harvest creel 22 tagged lampreys were recaptured. An additional two tags were reported by tribal fishers.

A primary tag retention rate was calculated for adult Pacific lamprey recaptured at Sherar's Falls. Tag retention was based on the presence of a fin clip and tag wound. Eight of the 35 lamprey recaptured at Sherar's Falls had lost their primary mark (77.1% primary mark retention).

Forty lampreys were tagged with numbered floy tags. Based on the tagged recaptures, we estimate lamprey returned to Sherar's Falls 3 - 7 days after being tagged (Table IV-3).

Table IV-2. Collection dates and catch per unit effort (CPUE) for adult Pacific lamprey collected using a long-handled dip net at Sherar's Falls, 2003.

Date	Lamprey collected	Hours	CPUE (lamprey/hr)
07/30/03	32	1.07	30.00
07/31/03	20	0.92	21.82
08/04/03	98	1.85	52.97
08/05/03	35	1.02	34.43
08/19/03	14	0.62	22.70

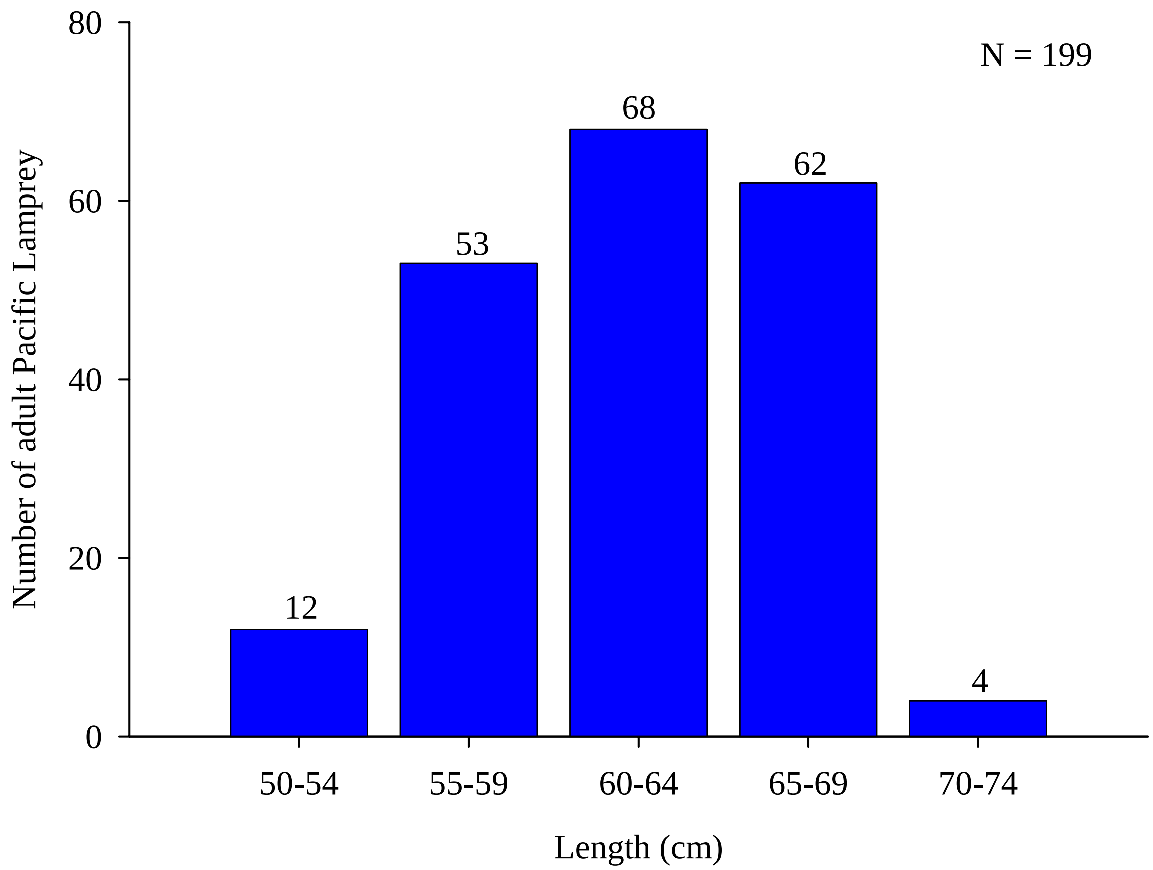

Figure IV-2. Length frequency for adult Pacific lamprey collected using a long-handled dip net at Sherar's Falls, 2003.

Table IV-3. Recaptured adult Pacific lamprey movement rate at Sherar's Falls, 2003.

Tagging Date	Tag Number	Length (cm)	Recapture Date	Movement Rate (days)
07/31/03	13993	68	8/5/2003	5
07/31/03	13990	64	8/4/2003	4
07/31/03	13994	61	8/7/2003	7
07/31/03	13996	68	8/4/2003	4
08/04/03	13905	60	8/7/2003	3
08/04/03	13910	63	8/10/2003	6

Adult Lamprey Harvest Monitoring

We conducted 21 interviews with tribal harvesters from 16 July to 20 August 2003. Tribal harvesters collected 585 adult Pacific lampreys. Of those 527 were collected during week days and 58 were collected during weekends. Total tribal harvest of adult Pacific lamprey was estimated to be 959 +/- 8.

Maximum, minimum and mean lengths for adult Pacific lamprey were 74 cm, 50 cm, and 62.1 cm, respectively (Appendix C). A length frequency histogram was completed for all lamprey collected through tribal harvest (Figure IV-3). No significant differences were found between the lamprey collected by dipnetting or tribal harvesters therefore it appears there is no size selectivity by tribal harvesters.

Adult Pacific lamprey were not present in the Sherar's Falls fish ladder prior to dark. Lampreys were visibly present in the ladder from 21:00 to beyond 03:00, when our surveys were completed. Peak nightly movement was at 00:00 (Figure IV-4). Bayer et al. (2000) found that adult Pacific lamprey only moved past fixed radio telemetry receivers in the John Day River at night.

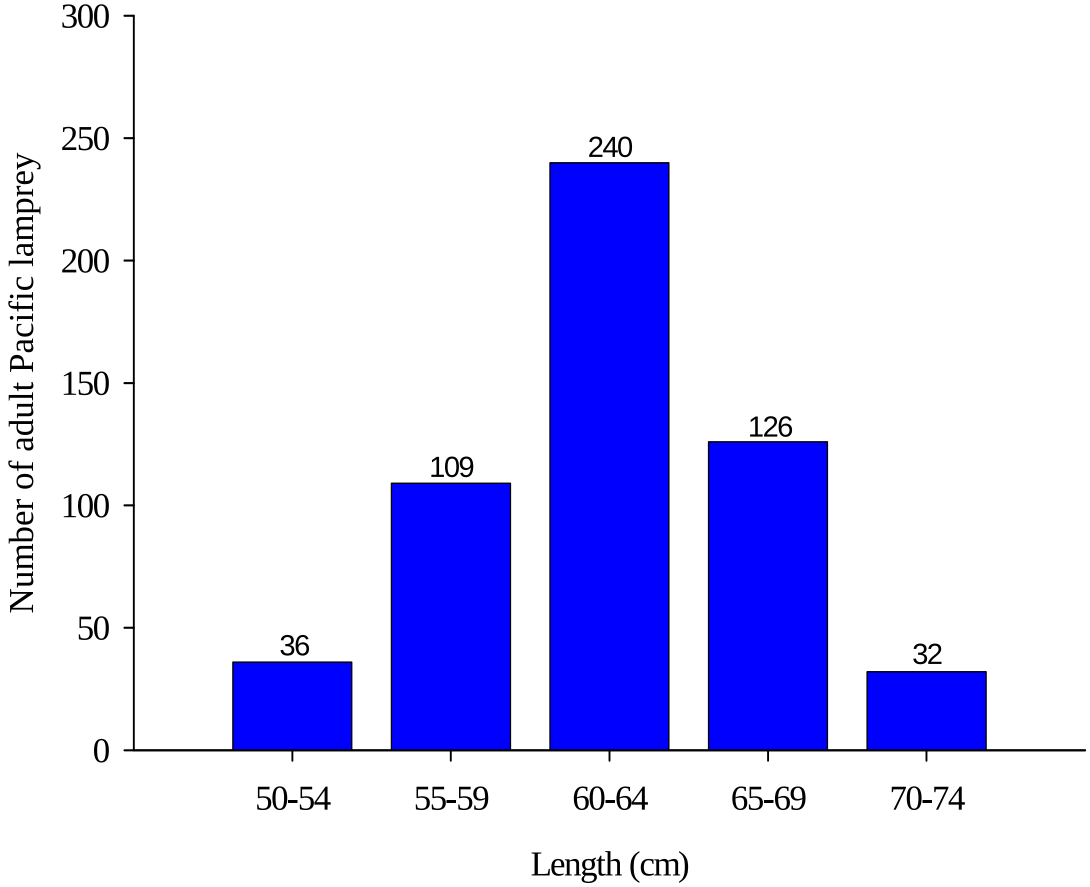

Figure IV-3. Length frequency for adult Pacific lamprey collected by tribal harvesters at Sherar's Falls, 2003.

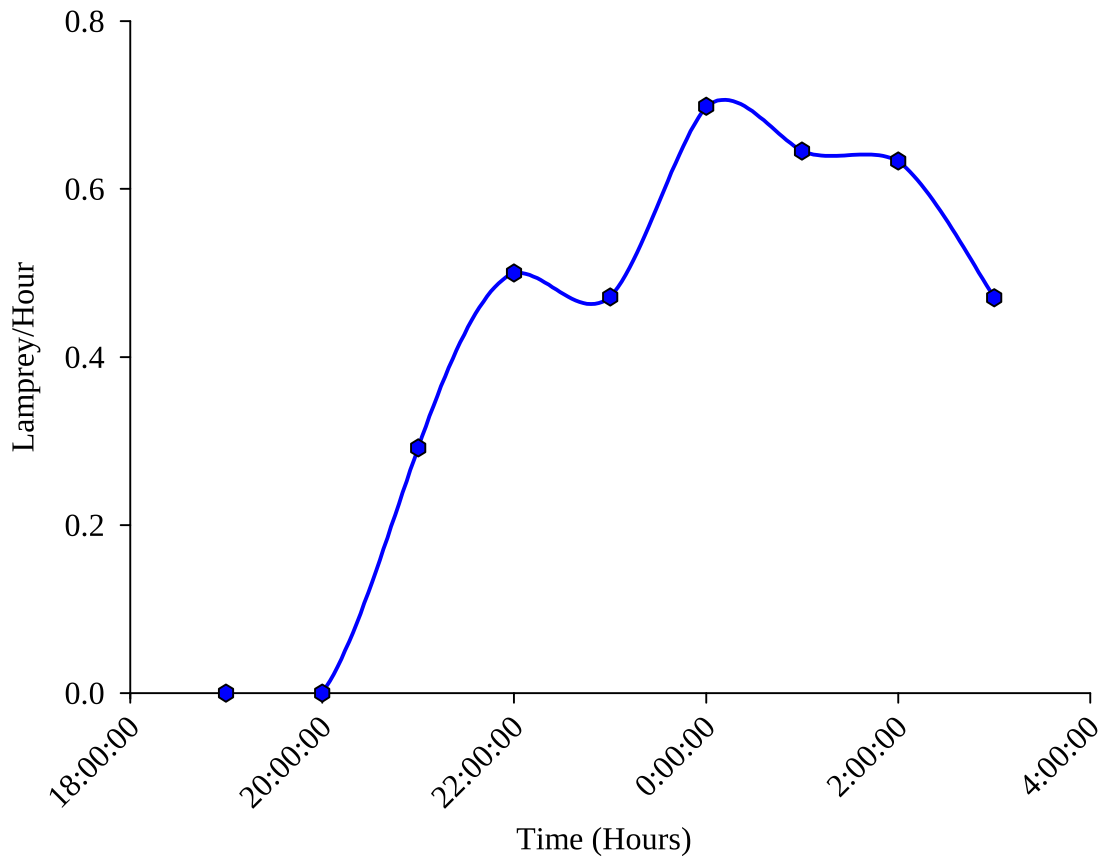

Figure IV-6. Peak movement timing of adult Pacific lamprey by hour at Sherar's Falls, 2003.

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References

Bayer, J. M., M. H. Meeuwig, and J. G. Seelye. 2000. Identification of larval Pacific lamprey (*Lampetra tridentata*), river lampreys (*L. ayersi*), and western brook lampreys (*L. richardsoni*) and thermal requirements of early life history stages of lampreys. Annual report to Bonneville Power Administration, Project Number 2000-029, Portland, Oregon.

Bayer, J. M., M. H. Meeuwig, and J. G. Seelye. 2001. Identification of larval Pacific lamprey (*Lampetra tridentata*), river lampreys (*L. ayersi*), and western brook lampreys (*L. richardsoni*) and thermal requirements of early life history stages of lampreys. Annual report to Bonneville Power Administration, Project Number 2000-029, Portland, Oregon.

Bayer, J. M., M. H. Meeuwig, and J. G. Seelye. 2002. Identification of larval Pacific lamprey (*Lampetra tridentata*), river lampreys (*L. ayersi*), and western brook lampreys (*L. richardsoni*) and thermal requirements of early life history stages of lampreys. Annual report to Bonneville Power Administration, Project Number 2000-029, Portland, Oregon.

Bayer, J. M., T. C. Robinson, and J. G. Seelye. 2000. Upstream migration of Pacific lampreys in the John Day River: Behavior, timing and habitat use. Annual report to Bonneville Power Administration, Project Number 2000-052, Portland, Oregon.

Beamish, R. J. 1980. Adult biology of the river lamprey (*Lampetra ayresi*) 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. 1987. Evidence that parasitic and nonparasistic life history types are produced by one population of lamprey. Canadian Journal of Fisheries and Aquatic Sciences 44: 1779-1782.

Beamish, R. J. and C. D. Levings. 1991. Abundance and freshwater migration 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.

Beamish, R. J. and R. E. Withler. 1986. A polymorphic population of lampreys that may produce parasitic and a nonparasitic varieties. In Info-Pacific Fish Biology; Proceedings of the Second International Conference on Indo-Pacific Fishes, ed. By Uyeno et al. Ichthyology Society of Japan, Tokyo. Pp. 31-49.

Beamish, R. J. and J. H. Youson. 1986. Life history and abundance of young adult *Lampetra ayresi* in the Fraser River and their possible Impact on Salmon and Herring Sticks in the Strait of Georgia. Canadian Journal of Fisheries and Aquatic Sciences 44: 525-537.

Bond, C. L. 1979. Biology of Fishes. Saunders, Philadelphia.

CBPLTWG. 1999. Planning of the Columbia Basin Pacific Lamprey projects and needs. Report to Northwest Power Planning Council and Bonneville Power Administration, Portland, Oregon.

Close, D. A. 1998. Pacific lamprey research and restoration project. Annual report to Bonneville Power Administration, Project #94-026, Portland, Oregon.

Close, D. 1999. Pacific lamprey research and restoration project. Annual report to Bonneville Power Administration, Project #94-026, Portland, Oregon.

Close, D. A. 2000. Pacific lamprey research and restoration project. Annual report to Bonneville Power Administration, Project #94-026, Portland, Oregon.

Close, D. A. 2001. Pacific lamprey research and restoration project. Annual report to Bonneville Power Administration, Project #94-026, Portland, Oregon.

Close, D. A., M. Fitzpatrick, H. Li, B. Parker, D. Hatch, and G. James. 1995. Status report of the Pacific lamprey (*Lampetra tridentata*) in the Columbia River Basin. BPA Report DOE/BP-39067-1, U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon.

Close, D. A. and K. K. Aronsuu. 2002. Pacific lamprey research and restoration project. Annual report to Bonneville Power Administration, Project #94-026, Portland, Oregon.

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

Cochnauer, T. and C. Claire. 2000. Evaluate Status of Pacific lamprey in the Clearwater River Drainage, Idaho. Annual Report to Bonneville Power Administration, Project #00-028, Portland, Oregon.

CRITFC. 1995. WY-KAN-USH-MI WA-KISH-WIT. The Columbia River anadromous fish restoration plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes. Portland, Oregon.

Hammonds, R. J. 1979. Larval biology of the Pacific lamprey, Entosphenus tridentatus (Gairdner), of the Potlatch River, Idaho. M.S. thesis, University of Idaho, Moscow, Idaho.

Hunn, E. S. and J. Selam. 1991. Nch'i-Wana "The Big River": Mid-Columbia Indians and their lands. University of Washington Press, Seattle, Washington.

Jackson, A. D, P. D. Kissner, D. R. Hatch, B. L. Parker, D. A. Close, M. S. Fitzpatrick, and H. Li. 1996. Pacific lamprey research and restoration. Annual report to Bonneville Power Administration, Project Number 94-026, Portland, Oregon.

Jackson, A. D., D. R. Hatch, B. L. Parker, D. A. Close, M. S. Fitzpatrick, and H. Li. 1997. Pacific lamprey research and restoration. Annual report to Bonneville Power Administration, Project Number 94-026, Portland, Oregon.

Kan T. T. 1975. Systematics, variation, distribution, and biology of lampreys of the genus *Lampetra* in Oregon. PhD. Dissertation, Oregon State University, Corvallis, Oregon.

Kostow, K. 2002. Oregon lampreys: Natural history status and problem analysis. Oregon Department of Fish and Wildlife, Portland, Oregon.

Long, C. W. 1968. Diel movement and vertical distribution of juvenile anadromous fish in turbine intakes. Fishery Bulletin 66:599-609.

Moser, M. L., L. C. Stuehrenberg, W. Cavender, S. G. McCarthy, and T. C. Bjornn. 2002. Radop Telemetry investigations of adult Pacific lamprey migration behavior: evaluation of modifications to improve passage at Bonneville Dam, 2000. Annual Report of Research to the U.S. Army Corp of Engineers, Portland District, Portland, Oregon.

Ocker, P. A., L. W. Stuehrenberg, M. L. Moser, A. L. Matter, J. J. Vella, B. P. Sanford, T. C. Bjornn, and K. R. Tolotti. 2001. Monitoring adult Pacific lamprey (*Lampetra tridentata*) migration behavior in the lower Columbia River using radiotelemetry, 1998-1999. Annual Report of Research to the U.S. Army Corp of Engineers, Portland District, Portland, Oregon.

O'Neal, L. B. 1987. AbP-2 operator's manual. Instrumentation Systems Center, University of Wisconsin, Madison.

Pajo, T. A. and J. G. Weise. 1994. Estimating populations of larval sea lamprey with electrofishing sampling methods. North American Journal of Fisheries Management 14:580-587.

Pletcher T. F. 1963. The life history and distribution of lampreys in the Salmon and certain other rivers in British Columbia, Canada. M.Sc. thesis, University of British Columbia, Vancouver, B.C.

Richards, J. E. 1980. Freshwater life history of the anadromous Pacific lamprey *Lampetra tridentata*. M.S. thesis, University of Guelph, Guelph, Ont.

Richards J. E., R. J. Beamish, and F. W. H. Beamish. 1982. Description and keys for ammocoetes of lamprey from British Columbia, Canada. Canadian Journal of Fisheries and Aquatic Sciences 39:1484-1495.

Scott, W. B. and E. J. Crossman. 1973. Freshwater fishes of Canada. Canadian Government Publishing Centre, Ottawa, Canada.

Stone, J, T. Sundlov, S. Barndt, and T. Coley. 2000. Evaluate habitat use and population dynamics of lampreys in Cedar Creek. Annual report to Bonneville Power Administration, Project Number 2000-014, Portland, Oregon

Stone, J, T. Sundlov, S. Barndt, and T. Coley. 2001. Evaluate habitat use and population dynamics of lampreys in Cedar Creek. Annual report to Bonneville Power Administration, Project Number 2000-014, Portland, Oregon

Stone, J., J. Pirtle, and S. Barndt. 2002. Evaluate habitat use and population dynamics of lampreys in Cedar Creek. Annual report to Bonneville Power Administration, Project Number 2000-014, Portland, Oregon.

Torgersen, C. E. and D. A. Close. 2000. Habitat heterogeneity and the spatial distribution of larval Pacific lamprey (*Lampetra tridentata*) in an Oregon stream. Bonneveille Power Administration, Project Number 94-026, Portland, Oregon.

van de Wetering, S. J. 1998. Aspects of life history characteristics and physiological processes in smolting Pacific lamprey, *Lampetra tridentata*, in a central Oregon stream. M.S. theses, Oregon State University, Corvallis, Oregon.

Vella, J., L. Steuhrenberg, and T. C. Bjornn. 1999. Migration patterns of Pacific lamprey (*Lampetra tridentata*) in the lower Columbia River, 1996. Annual Report of Research to the U.S. Army Corp of Engineers, Portland District, Portland, Oregon.

Vella, J., L. Steuhrenberg, and T. C. Bjornn. 2001. Migration patterns of Pacific lamprey (*Lampetra tridentata*) in the lower Columbia River, 1997. Annual Report of Research to the U.S. Army Corp of Engineers, Portland District, Portland, Oregon.

Vladykov, V. D. and W. I. Follett. 1958. Redescription of *Lampetra ayrii* (Gunther) of Western North America, a species of lamprey (Petromyzontidae) distinct from *Lampetra fluviatilis* (Linnaeus) of Europe. J. Fish. Bd. Canada 15:47-77.

Vladykov, V. D. and W. I. Follett. 1965. *Lampetra richardsoni*, a new nonparasitic species of lamprey (Petromyzonidae) from western North America. Journal of Fisheries Research Board of Canada 22:139-158.

Wydoski, R. S. and R. R. Whitney. 1979. Inland Fishes of Washington. University of Washington Press. Seattle and London.

Appendix A

Summary of rotary screw trap operations in Shitike Creek and Warm Spring River

Appendix A; Table 1. Number of days the rotary screw trap was operated and the number of lampreys by developemental state collected in the Shitike Creek, April 2003 – March 2004. N.O.= screw trap not operated.

Shitike Creek													
	2003									2004			2003-2004
	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Total
Days Fished	20	21	12	2	N.O.	5	14	16	4	N.O.	N.O.	18	112
Days with Lamprey	13	16	12	2	N.O.	0	10	11	4	N.O.	N.O.	16	84
Days without Lamprey	7	5	0	0	N.O.	5	4	5	0	N.O.	N.O.	2	28
Total Pacific lampreys collected	55	147	108	3	N.O.	0	35	23	55	N.O.	N.O.	65	491
Ammocoetes	55	147	108	3	N.O.	0	35	22	55	N.O.	N.O.	65	490
Macropthalmia	0	0	0	0	N.O.	0	0	1	0	N.O.	N.O.	0	1

Appendix A; Table 2. Number of days the rotary screw trap was operated and the number of lampreys by developmental stage collected in the Warm Springs River, April 2003 – March 2004.

Warm Springs River													
	2003									2004			2003-2004
	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Total
Days Fished	16	17	8	N.O.	N.O.	16	22	18	4	N.O	N.O	17	118
Days with Lamprey	11	14	5	N.O.	N.O.	4	12	15	4	N.O	N.O	16	81
Days without Lamprey	5	3	3	N.O.	N.O.	12	10	3	0	N.O	N.O	1	37
Total Pacific lampreys collected	51	72	16	N.O	N.O	5	14	43	18	N.O	N.O	117	336
ammocoetes	50	72	16	N.O	N.O	4	10	23	12	N.O	N.O	75	262
macropthalmia	1	0	0	N.O	N.O	1	4	20	6	N.O	N.O	36	68

Appendix B

Pacific lamprey length statistics for the Warm Springs River and Shitike Creek rotary screw tarps

Appendix B; Table 1. Length statisitics for Pacific lamprey ammocoetes collected in the Shitike Creek rotary screw trap from April 2003 – March 2004. N.O. = screw trap not operated.

	Shitike Creek												
	2003									2004			2003-2004
	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	All
Mean	105.30	102.06	87.37	64.00	N.O.	--	102.78	114.36	112.57	N.O.	N.O.	106.95	100.05
Standard deviation	17.28	36.61	17.37	5.00	N.O.	--	13.62	11.57	12.24	N.O.	N.O.	16.88	16.06
Standard error	2.29	3.52	1.72	2.89	N.O.	--	0.73	2.47	1.67	N.O.	N.O.	2.28	0.60
95% C.I.	4.59	6.98	3.41	12.39	N.O.	--	1.43	5.13	3.34	N.O.	N.O.	4.56	1.18
99% C.I.	6.10	9.24	4.51	28.23	N.O.	--	1.89	6.98	4.45	N.O.	N.O.	6.08	1.55
Sample size	57.00	108.00	102.00	3.00	N.O.	0.00	349.00	22.00	54.00	N.O.	N.O.	55.00	713.00
Sample total	6002.00	11023.00	8912.00	192.00	N.O.	--	35871.00	2516.00	6079.00	N.O.	N.O.	5882.00	71334.00
Minimum	61.00	48.00	44.00	59.00	N.O.	--	77.00	92.00	77.00	N.O.	N.O.	61.00	44.00
Maximum	141.00	420.00	122.00	69.00	N.O.	--	127.00	132.00	137.00	N.O.	N.O.	147.00	126.00

Appendix B; Table 2. Length statistics for Pacific lamprey ammocoetes in the Warm Springs River screw trap from April 2003 – March 2004. N.O. = screw trap not operated.

Warm Springs River													
	2003									2004			2003-2004
	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	All
Mean	81.14	77.89	88.56	N.O.	N.O.	77.50	80.22	87.35	80.33	N.O.	N.O.	89.68	83.57
Standard deviation	17.93	13.32	12.35	N.O.	N.O.	9.11	12.74	15.93	11.20	N.O.	N.O.	17.80	16.30
Standard error	2.53	1.58	3.09	N.O.	N.O.	4.56	4.25	3.32	3.23	N.O.	N.O.	2.07	1.01
95% C.I.	5.09	3.15	6.58	N.O.	N.O.	14.49	9.79	6.89	7.11	N.O.	N.O.	4.12	1.99
99% C.I.	6.79	4.19	9.10	N.O.	N.O.	26.56	14.25	9.37	10.04	N.O.	N.O.	5.47	2.63
Sample size	50.00	71.00	16.00	N.O.	N.O.	4.00	9.00	23.00	12.00	N.O.	N.O.	75.00	260.00
Sample total	4057.00	5530.00	1417.00	N.O.	N.O.	310.00	722.00	2009.00	964.00	N.O.	N.O.	6636.00	21645.00
Minimum	49.00	50.00	66.00	N.O.	N.O.	72.00	67.00	61.00	62.00	N.O.	N.O.	61.00	49.00
Maximum	134.00	118.00	110.00	N.O.	N.O.	91.00	107.00	127.00	95.00	N.O.	N.O.	136.00	136.00

Appendix B; Table 2. Length statistics for Pacific lamprey macropthalmia in the Warm Springs River screw trap from April 2003 – March 2004. N.O. = screw trap not operated.

Warm Springs River													
	2003									2004			2003-2004
	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	All
Mean	119.00	--	--	N.O.	N.O.	118.00	109.00	116.80	120.17	N.O.	N.O.	137.81	127.81
Standard deviation	0.00	--	--	N.O.	N.O.	0.00	11.49	12.19	24.96	N.O.	N.O.	11.99	16.98
Standard error	0.00	--	--	N.O.	N.O.	0.00	5.74	2.72	10.19	N.O.	N.O.	2.00	2.06
95% C.I.	--	--	--	N.O.	N.O.	--	18.28	5.70	26.19	N.O.	N.O.	4.06	4.11
99% C.I.	--	--	--	N.O.	N.O.	--	33.50	7.80	41.09	N.O.	N.O.	5.44	5.46
Sample size	1.00	0.00	0.00	N.O.	N.O.	1.00	4.00	20.00	6.00	N.O.	N.O.	36.00	68.00
Sample total	119.00	--	--	N.O.	N.O.	118.00	436.00	2336.00	721.00	N.O.	N.O.	4961.00	8691.00
Minimum	119.00	--	--	N.O.	N.O.	118.00	94.00	90.00	92.00	N.O.	N.O.	97.00	90.00
Maximum	119.00	--	--	N.O.	N.O.	118.00	118.00	138.00	153.00	N.O.	N.O.	159.00	159.00

Appendix C

Adult Pacific lamprey length statistics for the Sherar's Falls

Appendix C; Table 1. Length statistics for adult Pacific lamprey collected through long-handled dipnetting and creeling at Sherar's Falls, 2003.

	Netting – Lengths (cm)					Creeling – Lengths (cm)			
	June	July	August	All		June	July	August	All
Average	N.A.	68.89	61.19	61.89	Average	61.29	62.21	62.04	62.12
Count	N.A	52	147	199	Count	14	316	217	547
Max	N.A	72	73	73	Max	66.5	74	72	74
Min	N.A	57	51	51	Min	57.5	50	53	50
Standard Deviation	N.A	3.37	4.66	4.51	Standard Deviation	3.4	4.95	3.86	4.51
Variance	N.A.	11.39	21.68	20.35	Variance	11.53	24.48	14.92	20.33