FISH PASSAGE CENTER

1827 NE 44th Ave., Suite 240, Portland, OR 97213
Phone: (503) 230-4099 Fax: (503) 230-7559
http://www.fpc.org/
e-mail us at fpcstaff@fpc.org

MEMORANDUM

TO: Christina Luzier,
Howard Schaller,
David Wills

FROM: Jerry McCann and Brandon Chockley

DATE: September 14, 2011

RE: Results of 2011 Lamprey Monitoring and request for guidance for 2012

The FPC staff has summarized the lamprey monitoring data that were gathered as part of the Smolt Monitoring Program in 2011. The summary is provided as a beginning point for discussions of the lamprey monitoring component of the Smolt Monitoring Program for 2012. The FPC staff has put together results of the 2011 lamprey monitoring and ask that the Lamprey Technical Work Group (LTWG) review the results and provide guidance for monitoring in 2012.

In 2010 the FPC was approached with a request to make changes to lamprey monitoring. The LTWG had developed a list of critical monitoring needs, several of which were relevant to the SMP. The LTWG chair met with FPC staff and together developed a list of potential changes to lamprey monitoring that would address those critical needs that were deemed appropriate to the SMP. Among these changes were: 1) adopting a standardized approach to juvenile (and potentially adult) lamprey identification based on methods that the USFWS developed, 2) assigning a sample rate to juvenile lamprey that were sampled at SMP sites (as opposed to handling lamprey as "incidental species" whose counts were not associated with sample rates), and 3) outlining the implementation of a pilot study of condition monitoring. After meetings with USFWS and review by Fish Passage Advisory Committee (FPAC) the FPC adopted and implemented the changes to the monitoring program in 2011.

In addition to the changes outlined above, Fish Passage Center undertook more detailed reporting of lamprey collection data via the FPC website as well as adding data summaries to the FPC weekly reports. These efforts at real time data analysis were in response to requests from

FPAC. In response to requests by the ISAB, the FPC will add new data to the 2011 FPC Annual Report focused on lamprey data collected as part of the SMP.

Based on its initial analyses of the 2011 juvenile lamprey data, the FPC poses these questions for the LTWG to discuss for the 2012 sampling season:

- Should the changes adopted by SMP sites in 2011 be continued in future years?
- Should the condition monitoring of juvenile lamprey be expanded to other FCRPS projects? It is important to note that this may interfere the timely processing of SMP samples at some sites, particularly those sites that need to have the samples worked up before a barge can be loaded.
- Are there any other foreseeable data needs that may be addressed by the SMP sampling efforts at the dams or traps.

Methods

Lamprey Identification

Juvenile lamprey (and adult lamprey that may be collected in the SMP sample) were identified using guidelines developed by USFWS. Prior to the start of sampling in 2011 the FPC and USFWS held a preseason meeting at which SMP site personnel were trained in new fish identification methods. Prior to 2011, juvenile lamprey were identified as being either "brown", "silver", or simply "juvenile". In 2011, the SMP moved to identifying juvenile lamprey to life-stage and species. The protocol used by the sites for lamprey identification is summarized below.

Lamprey juveniles (or adults) were identified to species and life-stage in 2011. Pacific lamprey (*Entosphenus tridentata*) and brook lamprey (*Lampetra richardsoni*) were the two species most likely to be encountered by SMP personnel. When a lamprey ammocoete (larva) was collected a key was used to determine species. Ammocoete were identified as those juvenile lamprey with eyes absent and oral disk absent. If total length (TL) of the ammocoete was less than 70 mm then the fish was identified as unknown lamprey ammocoete. For ammocoete greater than 70 mm, species could be identified based upon the color pattern of the caudal region (Figure 1). Ammocoetes that had a uniformly dark caudal fin with a caudal ridge that was faded and appeared lighter than fin were identified as Pacific lamprey. Whereas those ammocoetes that had a mottled caudal fin with broad margins lacking pigment; or that appeared blotchy, peppered or completely clear were identified as Western Brook lamprey.

If caudal region coloration was not definitive, ventral surface coloration was also used as an additional second characteristic for identification. If the ammocoete had a light ventral surface it could have been identified as a Pacific lamprey, otherwise a mottled or uniformly dark ventral surface was considered an indication of Western Brook lamprey. If no determination was possible based on these criteria, the lamprey was identified as an unknown lamprey ammocoete.

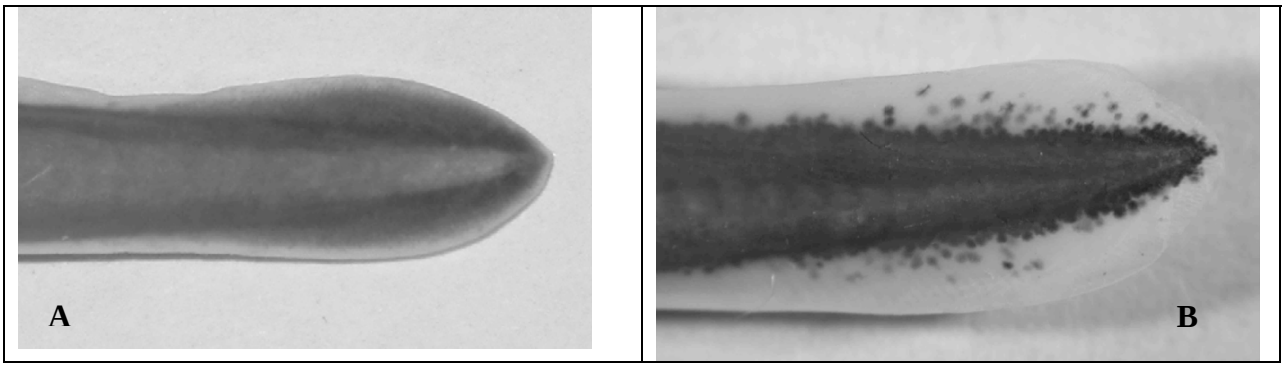

Figure 1. Comparison of caudal region of *Entosphenus tridentate (A) and Lampetra spp (B)* ammocoete from USFWS lamprey identification guide used by the Smolt Monitoring Program.

Since western brook lamprey do not exhibit a macropthalmia or juvenile life stage the macropthalmia designation was used for lamprey identified as pacific lamprey juveniles. Macropthalmia are eyed juvenile lamprey with oral disk present and for Pacific lamprey these individuals range in size between 100 and 160 mm. Because Western Brook lamprey adults range between 100 and 200 mm it was important that distinct characteristics were used to identify these different species (and life stages). Based on the USFWS key, the SMP used the relative size of the eye of Pacific lamprey juvenile compared to Western Brook lamprey adults as a key to identifying the different species/life stages (Figure 2). Pacific lamprey macrothalmia were identified by the large eye that was equal in diameter to the distance between the posterior edge of the eye to the first branchial pore. By comparison, the Western Brook lamprey adults were identified by the much smaller eyes on lamprey between 100 and 200 mm (Figure 2).

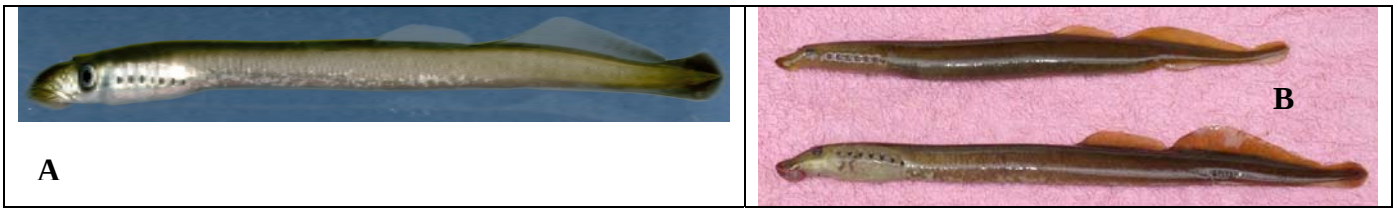

Figure 2. Comparison of the relative eye size of Pacific lamprey macrothalmia (A) and Western Brook lamprey adults (B). Figure from the USFWS key to lamprey identification used by the SMP.

In addition, adult lamprey collected in the SMP samples were identified using USFWS pamphlets as well as the guide book **"**Inland fishes of Washington**:** First Addition" 1979. R. Wydoski and R. Whitney eds.

Lamprey Counts, Passage Timing, and Mortality

The Smolt Monitoring Program implemented a new data entry procedure in 2011 that allowed juvenile lamprey sample data to be directly related to sample rates used in fish collection. In the past, the SMP recorded lamprey as "incidental species" such that all fish in the sample were simply counted and reported and no sample rate information was available. Under the new procedures developed for 2011, SMP sites were able to report lamprey sample numbers with an associated sample rate similar to what is done for juvenile salmon. Therefore, more

accurate collection counts could be estimated, based on when and where each juvenile lamprey was sampled (i.e., separate sample rates for different tanks or at different times of the day).

In addition to more accurate collection information, mortality data were required as part of the data recording in 2011. This will allow comparisons of mortality rates between lamprey and other species. In the past, lamprey mortality data have been collected but in a few years it was not collected at all projects.

Lamprey Condition Monitoring

A pilot study was carried out at John Day Dam in 2011 to gather information of the condition of juvenile lamprey entering the bypass systems at the dam. It was the first year and site to record these data so examination and handling protocols were developed by the site personnel as the season progressed. One hundred lamprey of both ammocoete and macropthalmia life stages of Pacific lamprey were weighed and measured and examined for detailed disease, injury and mortality information. The methods of data entry followed procedures developed for examining juvenile salmon for condition monitoring.

Specimens for condition exams were obtained from the SMP sample holding tank as part of the bycatch or non-target sample of fish diverted into the smolt monitoring facility for routine smolt monitoring purposes. (The sample rate was never raised on purpose to catch more lamprey than would be normally sampled in our attempt to get our SMP sample size of smolt.)

In general, most lamprey were removed from the sample holding tank before the start of sampling and placed in 5 gallon buckets of fresh river water or into a temporary holding tank. It is difficult to capture and remove all lamprey without causing stressful holding conditions for juvenile salmon, but the lamprey tend to swim along the edges of the tank and hold in the corners, so there was some amount of natural separation which helped reduce stress levels. After at least 100 of each type of lamprey were randomly selected from the sample, any extra lamprey were immediately counted, tallied, and released.

After processing smolts for the day, about 40 individual lampery were placed into the sorting trough (42L). These fish were anesthetized using a solution of MS-222 at a rate of 48mg/L for approximately 4 minutes. Condition exam data collection categories included the total length (mm), total weight (nearest 0.1 gram), and maladies such as injuries and diseases. Examinations ranged from about 13 to 22 seconds per fish, but averaged about 15 seconds per lamprey. After the examination, lamprey were released into a recovery tank and held for at least 30 minutes to ensure enough time to recover from the anesthetic and then they were released to tailrace through normal exit routes. This process was repeated until all lamprey were examined.

Results

2011 Lamprey Counts, Passage Timing, and Mortality

Lamprey Juvenile Counts

Prior to the 2011 SMP season, juvenile lamprey were recorded as incidental species, typically as lamprey silver, lamprey brown, or lamprey juvenile. As mentioned above, the 2011 SMP season is the first sampling season where lamprey juveniles were recorded as target species

(similar to salmonids) and were identified to life-stage and species. The four life-stage/species combinations for lamprey juveniles were: 1) Pacific Macropthalmia (MP), 2) Pacific Ammocoete (AP), 3) Brook Ammocete (AB), and 4) Unknown Ammocoete (AS). By treating lamprey juveniles as target species in the SMP, a specific sample rate could be applied to the lamprey juveniles that were sampled. This allows for the expansion of the sample counts to a collection count, based on sub-batch specific sample rates.

Below is a summary of the sample and collection counts that were recorded in 2011 at each of the SMP sites (through September 11, 2011) (Table 1). Although all SMP sites made the change to including lamprey juveniles as target species in 2011, there were no lamprey juveniles sampled at the SMP trap sites in 2011. Furthermore, no brook lamprey ammocoetes were encountered by SMP site personnel in 2011 (Table 1). At the Lower Columbia and Upper Columbia sites (BON, JDA, MCN, and RIS), the majority of lamprey juveniles that were sampled were pacific lamprey macropthalmia. Pacific lamprey ammocoetes made up the majority of the juvenile lamprey sample at LGS and LGR. However, when expanded for sample rates, pacific macropthalmia made up the majority of the collection at LGS. Very few lamprey juveniles were sampled at LMN in 2011.

Table 1. Total sample and collection counts of lamprey juveniles for 2011 SMP season (through Sept. 11, 2011). SMP trap sites did not collect any lamprey juveniles in 2011.

	Sample Counts				Collection Counts			
Site	**MP**	**AP**	**AB**	**AS**	**MP**	**AP**	**AB**	**AS**
BON*	2,203	72	0	0	25,383	713	0	0
JDA*	10,680	1,984	0	0	466,479	28,215	0	0
MCN*	6,553	28	0	2	319,398	1,150	0	40
LMN*	8	1	0	0	1,045	1	0	0
LGS*	150	2,011	0	0	21,392	6,580	0	0
LGR	47	371	0	0	4,397	6,164	0	0
RIS	271	54	0	1	272	55	0	1

* Sample and collection counts were extrapolated for non-sample days at these sites. LMN and LGS sampled every 3rd or 4th day in the early season, MCN had every-other-day sampling from 4/13-7/19, and BON and JDA had some non-sample days in late August-early September due to temperature protocols.

Passage Timing

Some SMP sites (LGS, LMN, MCN) sample fish from two different sample tanks, which can have different sample rates. Other sites (BON, JDA) often change their sample rates throughout the day, depending on whether increased sampling is necessary to collect research fish or for other reasons. Prior to the 2011 sampling season, the only way to expand the incidental lamprey juvenile counts to a collection count was to use an estimated daily average sample rate, based on the salmonid collection at each site, and applying that to the incidental sample count for lamprey juveniles at that site. However, depending on the configuration and operations at a particular site, this may have an impact on the estimated collection count. By incorporating lamprey juveniles as target species, actual sample rates can be applied to lamprey sample counts, which allows for more reliable estimates of collection. This is particularly important when addressing lamprey passage timing through the hydrosystem, as collection counts are often used to describe passage timing.

To demonstrate the impact of collection estimates on the estimation of passage timing, the FPC staff estimated the passage timing of pacific macropthalmia and pacific ammocoetes in 2011. We estimated passage timing using two methodologies: 1) by using the actual collection counts that were made possible by the changes in 2011 SMP season and 2) by estimating an average daily sample rate from salmonid collections and applying that to the daily sample counts of juvenile lamprey. We did this for the sites where configurations and operations were expected to have an impact on estimation of collections, given that a daily average sample rate may sometimes be bias. Lower Monumental Dam only encountered lamprey juveniles on four separate days (3 days of pacific macropthalmia and 1 day of pacific ammocoetes). Due to the low number of incidences where lamprey juveniles were encountered at LMN, we did not include this site in this analysis.

Based on our review of lamprey collection data, it appears there were some differences in timing based on the new method of linking sample numbers to specific sample rates. In most cases, for both ammocoetes and macropthalmia, the new method resulted in earlier timing distribution of collection counts. The largest difference for macropthalmia was seen at Little Goose Dam where the 50% passage date was calculated as April 12 using new method while the 50% sample date was May 18 under the old method (Table 2). Little Goose Dam would be expected to show a difference in this comparison since that site has multiple two sample tanks and samples at different rates to collect fish for sampling in the tanks. Thus an average sample rate may not reflect the rate at which incidental species were collected if tanks differed in what sample rates were being used.

Table 2. Estimated 10%, 50%, and 90% passage dates for pacific lamprey macropthalmia in 2011, based on estimated collection counts. New method is based on collection counts from actual sample rates while old method is based on collections from average daily sample rates.

	Old Method			New Method		
Site	**10%**	**50%**	**90%**	**10%**	**50%**	**90%**
BON	23-Mar	16-Apr	29-May	25-Mar	15-Apr	29-May
JDA	12-Apr	24-May	16-Jun	12-Apr	24-May	16-Jun
MCN	22-Apr	25-May	26-Jun	23-Apr	24-May	16-Jun
LMN	17-May	19-May	20-May	18-May	19-May	20-May
LGS	7-Apr	18-May	21-May	6-Apr	12-Apr	19-May
LGR	6-Apr	8-Apr	17-May	6-Apr	8-Apr	17-May
RIS	19-Apr	17-May	8-Jun	19-Apr	17-May	8-Jun

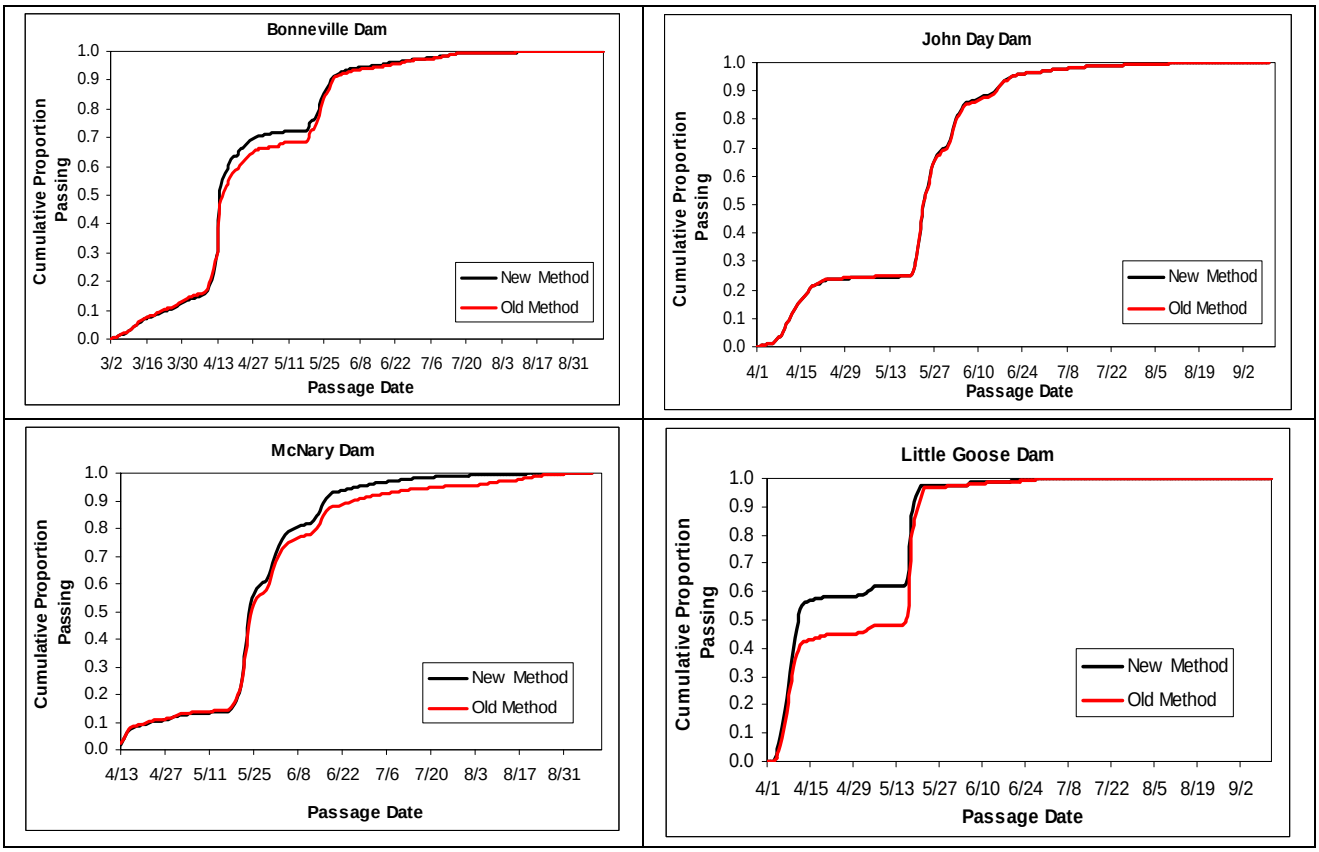

Figure 3. Cumulative passage timing curves for Pacific lamprey macroptalmia at BON, JDA, MCN, and LGS for 2011, based on estimated collection counts. New method is based on collection counts from actual sample rates while old method is based on collections from average daily sample rates.

Ammocoete timing at Bonneville and McNary dams was also earlier using the new method of assigning sample rates to samples (Figure 4). The odd pattern seen at Little Goose Dam was due to an unusual situation where a relatively large number of lamprey ammocoetes were collected at 100% sample rate but the estimated average sample rate for the day (for all smolts and lamprey) was very low resulting in a large expansion to the collected lamprey number using the old method.

Table 2. Estimated 10%, 50%, and 90% passage dates for pacific lamprey ammocoetes in 2011, based on estimated collection counts. New method is based on collection counts from actual sample rates while old method is based on collections from average daily sample rates.

	Old Method			New Method		
Site	**10%**	**50%**	**90%**	**10%**	**50%**	**90%**
BON	9-Apr	31-May	31-Jul	9-Apr	28-May	31-Jul
JDA	5-Apr	18-May	25-May	5-Apr	18-May	24-May
MCN	21-May	24-Jun	10-Jul	20-May	19-Jun	5-Jul
LMN	26-Aug	26-Aug	26-Aug	26-Aug	26-Aug	26-Aug
LGS	22-May	30-Jun	4-Aug	22-Jun	7-Jul	4-Aug
LGR	13-May	8-Jul	17-Jul	13-May	8-Jul	17-Jul
RIS	30-Apr	18-May	21-Jul	30-Apr	18-May	21-Jul

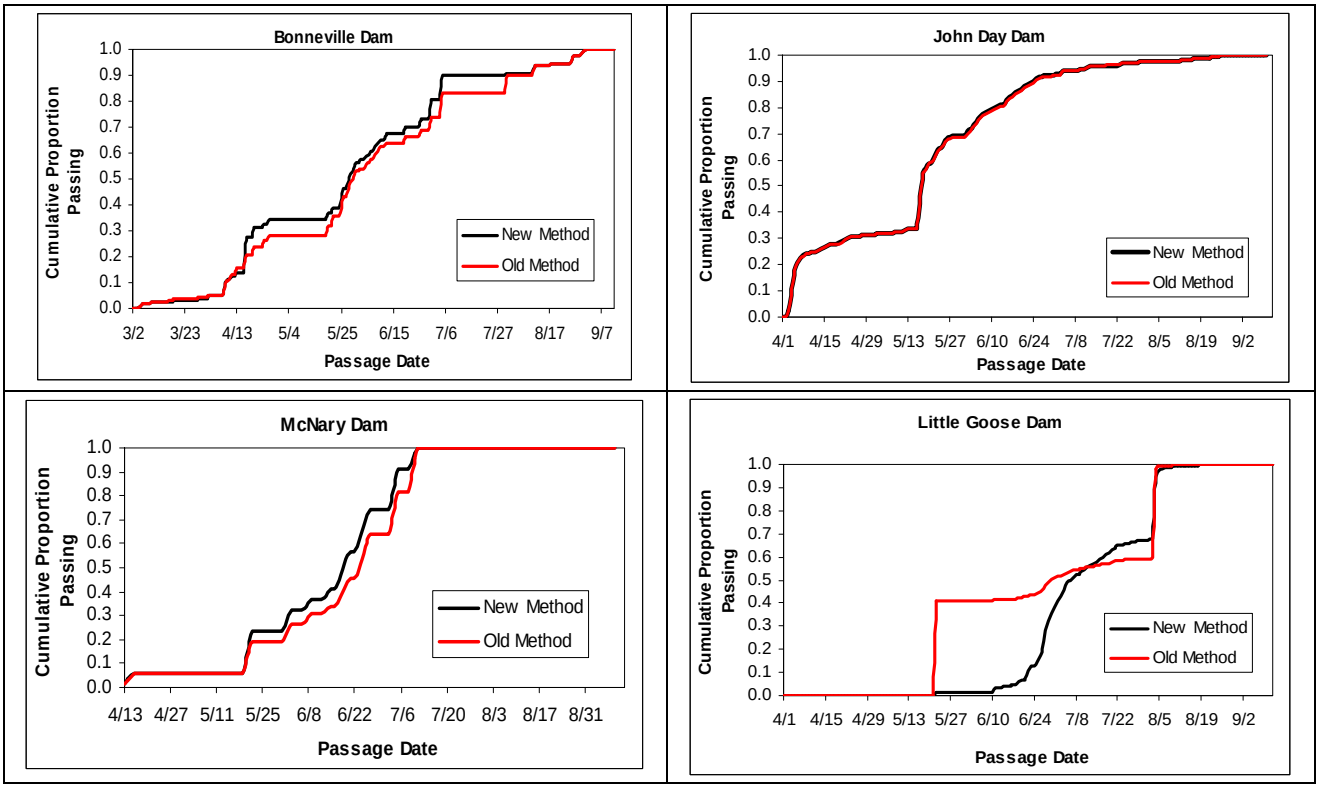

Figure 4. Cumulative passage timing curves for Pacific lamprey ammocoetes at BON, JDA, MCN, and LGS for 2011, based on estimated collection counts. New method is based on collection counts from actual sample rates while old method is based on collections from average daily sample rates.

Mortality

A comparison of lamprey mortality rates in 2011 at three different dams showed that juvenile lamprey tended to have a higher incidence of mortality than Chinook salmon examined over the season. This was particularly true at Bonneville Dam (Figure 5) where mortality percentages for Chinook were often near zero while lamprey mortality percentages varied equally between 4% and 20%. A similar pattern of higher proportion of samples with higher mortality rates was also seen at McNary Dam (Figure 7).

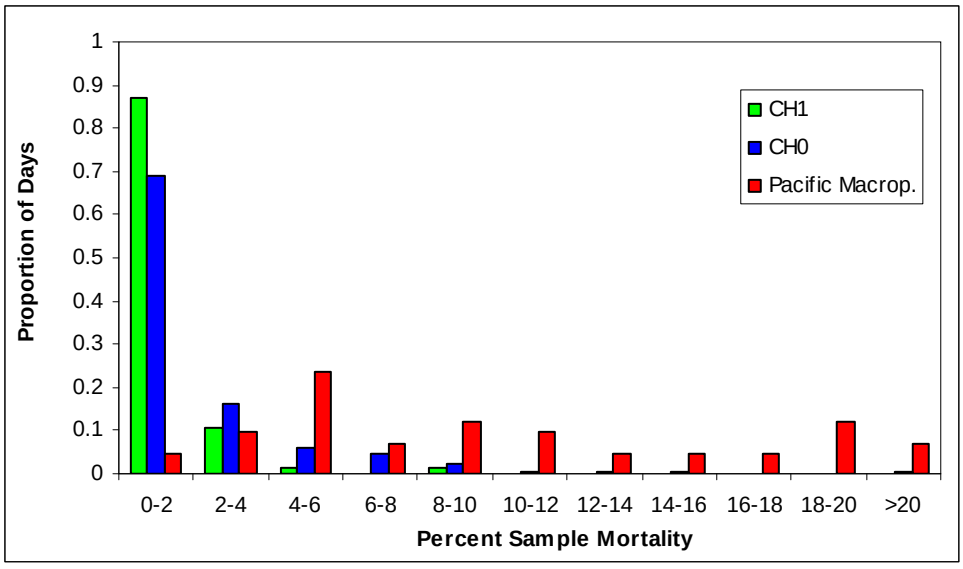

Figure 5. Frequency histogram of percent sample mortality for yearling Chinook, subyearling Chinook, and pacific lamprey macropthalmia at Bonneville Dam in 2011.

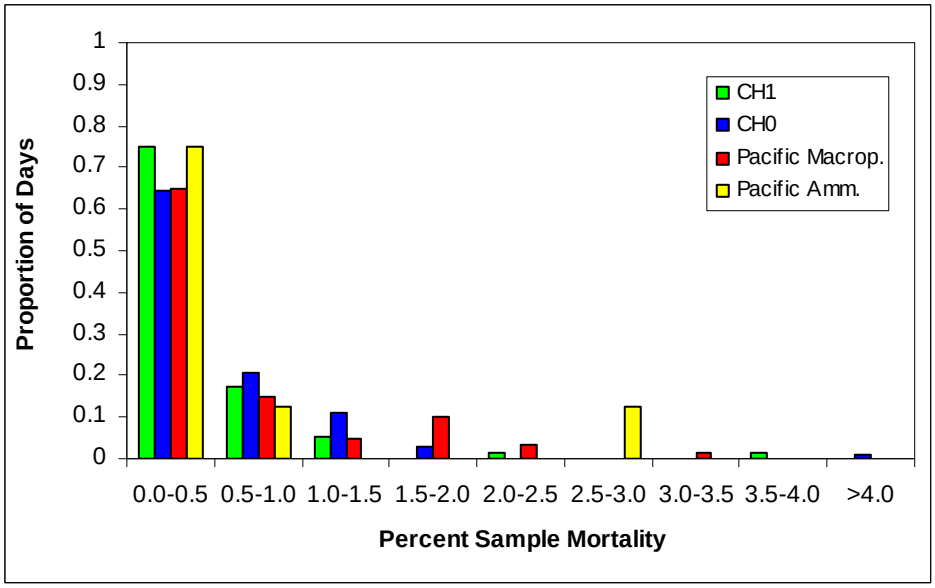

Figure 6. Frequency histogram of percent sample mortality for yearling Chinook, subyearling Chinook, pacific lamprey macropthalmia, and pacific lamprey ammocoetes at John Day Dam in 2011.

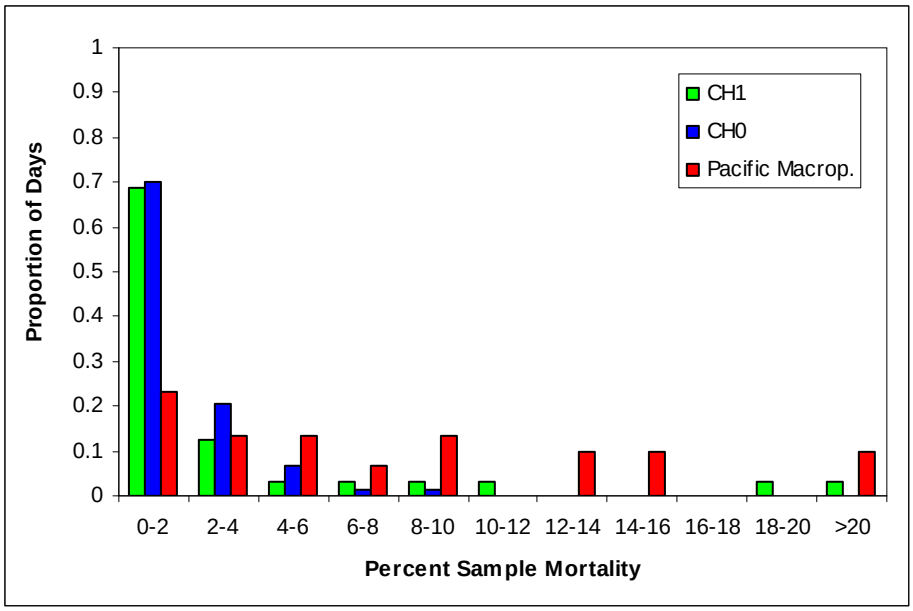

Figure 7. Frequency histogram of percent sample mortality for yearling Chinook, subyearling Chinook, and pacific lamprey macropthalmia at McNary Dam.

Lamprey Condition Monitoring

A total of 5,089 juvenile pacific lamprey were examined for condition at John Day Dam through September 14, 2011. There was one day of sampling left at the time of this writing. Of the lamprey examined in condition sampling 849 were ammocoetes and 4,240 were macropthalmia (Table 3). There was a relatively high injury percentage for the macropthalmia at 11%. Most of the injuries were to the body and fins of the macropthalmia. According to personnel at the site those injuries were often "tick marks down the body". Site personnel thought the injuries could have been caused by contact with bypass screen equipment or predators. External signs of disease were low in lamprey juveniles compared to salmon smolts. Only 10 lamprey macropthalmia showed external evidence of disease, all of which were fungus.

Table 3. A Summary of condition monitoring data for juvenile lamprey seen at John Day Dam in 2011by life stage is shown below. Chinook yearling and subyearling data are included for comparison. Codes for species are; AP--Pacific lamprey ammocoete; MP--Pacfic lamprey macropthalmia; CH0--subyearling Chinook salmon; CH1--yearling Chinook salmon.

Species	Exams	Injury	Pct. injury	Disease	Avg. Length mm	Avg. Weight g
AP	849	53	6.2%	0	146	5.2
MP	4,240	472	11.1%	10	143	4.2
CH0	14,078	240	1.7%	732	104	NA
CH1	3,095	261	8.4%	80	151	NA

The ammocoetes tended on average to be slightly larger than macropthalmia that were sampled. The average length of ammocoetes was 146 mm and average weight was 5.2 g. While macropthalmia average 143 mm and weighed on average 4.2 g. A plot of the length-weight

relationship for ammocoetes and macropthalmia showed that ammocoetes weighed more at a given length than macropthalmia (Figure 8). Most ammocoetes passed early in the season. There were only 8 days when 20 or more ammocoetes were available for condition sampling. Six of those dates were before April 10 and two dates in mid-May. By contrast there were 51 days when there were 20 or more macropthalmia in the sample stretching from early April through the end of June.

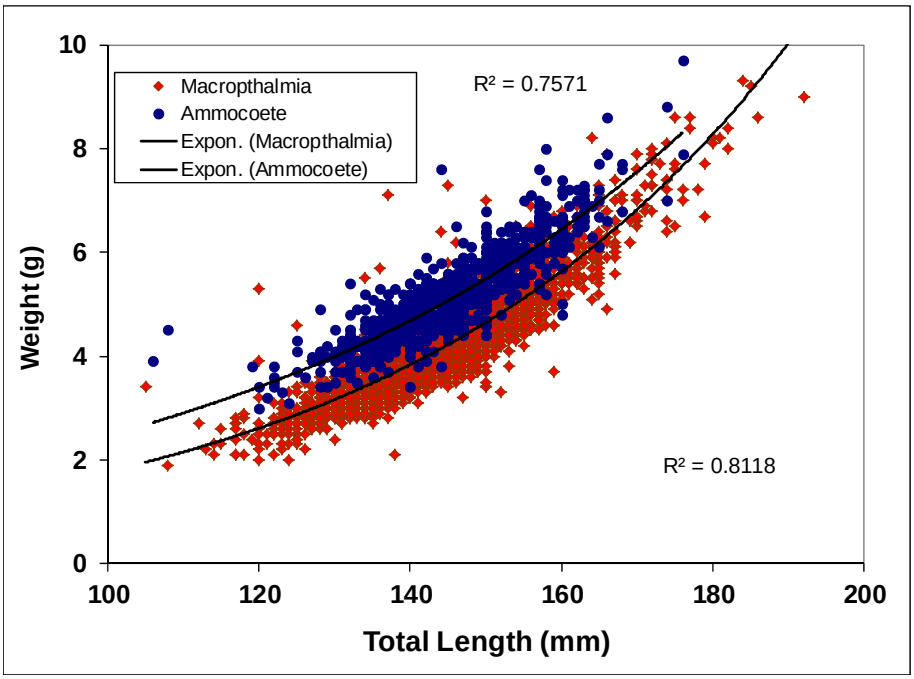

Figure 8. Length-weight relationship of Pacific lamprey ammocoete and macropthalmia that were sampled at John Day Dam in 2011 and examined as part of condition monitoring.