



# FISH PASSAGE CENTER

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## MEMORANDUM

TO: Christina Luzier (USFWS),  
Howard Schaller (USFWS),  
David Wills (USFWS),  
Brian McIlraith (CRITFC)

FROM: Brandon Chockley,

DATE: November 14, 2012

RE: Results of 2012 lamprey monitoring

In response to a request from the Lamprey Technical Workgroup (LTWG) leadership, the Fish Passage Center (FPC) staff has summarized the lamprey monitoring data that were gathered as part of the Smolt Monitoring Program (SMP) in 2012. Given that 2012 is the second year of the new lamprey monitoring program, we are also providing a summary of the results from 2011. Below is a brief summary of our findings from these analyses, followed by a more detailed description of the analyses we conducted.

- In 2012, all SMP sites were successful in collecting lamprey data under the new lamprey monitoring program that was first implemented in 2011. There were no major issues with data collection.
- The expansion of lamprey condition monitoring to Bonneville, John Day, and McNary dams was successful in 2012.
  - More work is needed in distinguishing between body injuries that are attributable to the bypass systems and those that may be caused by predators. FPC staff, SMP personnel, and USFWS staff plan to work together in 2013 to better define these condition metrics.
- For the second year, sample counts at the Snake River and Upper Columbia River SMP sites were relatively low. At this time the FPC does not feel that lamprey condition monitoring can be expanded to any of these sites.

- It appears that lamprey juveniles, particularly Pacific macrophthalmia, are experiencing higher mortality at Bonneville and McNary dams than salmonids. Comparisons of lamprey mortality rates to those of salmonids at Snake River and Upper Columbia River sites was not possible, due to relatively low sample counts. Further investigation is needed to determine why lamprey mortality rates are higher at BON and MCN.

## Background

In 2010 the FPC was approached with a request to make changes to the collection of lamprey data for the SMP. The LTWG chair met with FPC staff and together developed a list of changes to lamprey monitoring that would address the critical needs that were deemed appropriate to the SMP. Among these changes were: 1) adopting a standardized approach to identifying larval and juvenile lamprey using USFWS identification methods, 2) treating larval and juvenile lamprey as target species and, thus, assigning a sample rate to lamprey samples at SMP sites (as opposed to treating them as “incidental species”), and 3) implementing a pilot study of lamprey condition monitoring. After meetings with USFWS staff and review by the Fish Passage Advisory Committee (FPAC) the FPC adopted and implemented these changes to the monitoring program in 2011.

After the 2011 SMP season ended, the FPC prepared a summary of the lamprey monitoring data for the LTWG to review. This report is available on the FPC website (<http://www.fpc.org/documents/memos/169-11.pdf>). The FPC also added larval and juvenile lamprey to many of the on-line queries of SMP data as well as adding lamprey to many of the daily and weekly reports of SMP data. In response to requests by the ISAB, the FPC added lamprey data to the 2011 FPC Annual Report.

In addition, the FPC staff asked for guidance on lamprey monitoring in future years. Based on their review of the 2011 data, the LTWG asked that the new lamprey monitoring protocol be continued in 2012 and future years. The LTWG also requested that the lamprey condition monitoring be expanded wherever possible. The FPC determined that the lamprey condition monitoring could only be expanded in the Lower Columbia River, as these were the only sites that sampled larval and juvenile lamprey in large enough numbers.

Therefore, in 2012, all SMP sites continued to follow the lamprey monitoring protocol that was first implemented in 2011. In addition, the lamprey condition monitoring was expanded to Bonneville Dam (BON), John Day Dam (JDA), and McNary Dam (MCN) in the Lower Columbia River.

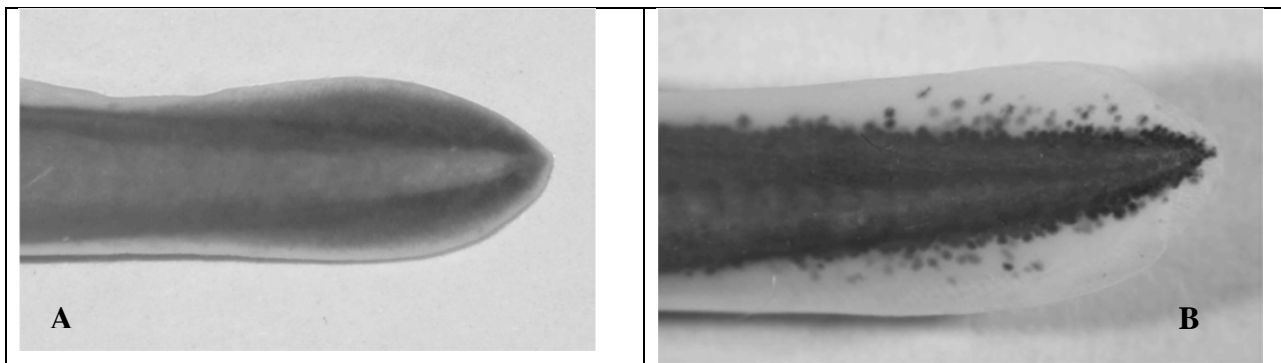
## Methods

### *Lamprey Identification*

In 2012, larval and juvenile lamprey were identified using guidelines developed by USFWS. Prior to the start of sampling in 2012 the FPC and USFWS held a preseason meeting at which SMP site personnel were trained in new fish identification methods. As in 2011, larval and juvenile lamprey were identified to species and life-stage in 2012. Pacific lamprey (*Entosphenus tridentatus*) and Western 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. Ammocoetes were identified as those 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 ammocoetes 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 the fin were identified as Pacific lamprey (Figure 1A). 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 (Figure 1B).

If caudal region coloration was not definitive, ventral surface coloration was also used as an additional 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 tridentatus* (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 macrophthalmia (or juvenile) life stage the macrophthalmia designation was used for lamprey identified as Pacific lamprey. Macrophthalmia are eyed juvenile lamprey with oral disk present and for Pacific lamprey these individuals range in size between 100 and 160 mm TL. Because Western Brook lamprey adults range between 100 and 200 mm TL 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 macrophthalmia 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 (Figure 2A). By comparison, the Western Brook lamprey adults were identified by the much smaller eyes on lamprey between 100 and 200 mm TL (Figure 2B).



**Figure 2.** Comparison of the relative eye size of Pacific lamprey macrophthalmia (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. Adult lamprey continue to be recorded as incidental species.

### ***Lamprey Counts, Passage Timing, and Mortality***

In 2012, the SMP continued to use the new data entry procedure that began in 2011. This new data entry procedure allowed larval and juvenile lamprey sample data to be directly related to sample rates used in fish collection. In the past, the SMP staff recorded larval and juvenile lamprey as “incidental species” such that all fish in the sample were simply counted and reported and no sample rate information was available. Without sample rate information, estimation of collections was not possible. Under the new procedures developed for 2011, SMP sites were able to report larval and juvenile lamprey sample numbers with an associated sample rate similar to what is done for juvenile salmon. This allowed for the estimation of collection counts, based on when and where each larval or juvenile lamprey was sampled (i.e., separate sample rates for different tanks or at different times of the day).

Estimates of collection are made by expanding the sample count based on the sample rate that was being used when the sample was made. Each site has the ability to adjust the sample rate, either to different sample tanks and/or at different times of the day. The sample rate determines how much time the sample gate is open in a given hour. For example, a sample rate of 10% corresponds to having the sample gate open for 6 minutes in an hour. Sample rates are chosen by site personnel based on how many total fish are expected to be handled each day. As a general goal, the SMP aims to sample between 300 and 500 total target fish per day. This sampling goal weighs the desire to limit handling while still allowing for the collection of accurate and precise estimates of collection. In addition, lamprey mortality data were also collected, which allows for comparisons of mortality rates between lamprey and other species and between sites.

### ***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. Information gathered during this pilot study resulted in the development of a lamprey condition monitoring protocol, which is available on the FPC website ([ftp://ftp.fpc.org/FPC32.net/Manuals/ConditionSamplingProtocol\\_2012.pdf](ftp://ftp.fpc.org/FPC32.net/Manuals/ConditionSamplingProtocol_2012.pdf)). Based on the results of this pilot study, the LTWG requested that this condition monitoring be expanded to as many sites as possible. In 2012, condition monitoring was expanded to Bonneville Dam, John Day Dam, and McNary dams. All three of these sites followed the above mentioned lamprey monitoring protocol.

## **Results**

### ***2012 and 2011 Lamprey Counts, Passage Timing, and Mortality***

#### ***Larval and Juvenile Lamprey Counts***

As mentioned above, lamprey juveniles were recorded as target species in both 2011 and 2012 and were identified to life-stage and species. The four life-stage/species combinations for lamprey juveniles were: 1) Pacific Macrophthalmia (MP), 2) Pacific Ammocoete (AP), 3) Western Brook Ammocoete (AB), and 4) Unknown Ammocoete (AS). In 2012, the SMP added a fifth juvenile lamprey category, Unidentified Lamprey (LU). This category was intended to be used for lamprey juveniles that were collected during separator clean-out procedures where species and life-stage identification may not have been possible. It was expected that this category would rarely be used.

By treating larval and juvenile lamprey 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 2012 at each of the SMP sites, as well as the collection counts from 2011 (Table 1).

Although larval and juvenile lamprey are target species at all SMP sites (except the Imnaha Trap), only one SMP trap has collected a lamprey juvenile since the new protocol began. In all, six Pacific ammocoetes were sampled at the Salmon River Trap at Whitebird, ID (WTB) in 2012 (Table 1). Furthermore, no western brook lamprey ammocoetes have been encountered by SMP site personnel since the new monitoring program began in 2011 (Table 1).

For almost all sites, in both years, Pacific lamprey macrophthalmia made up the majority of the lamprey sample and collection (Table 1). The only exception to this was at Lower Granite Dam (LGR) where Pacific ammocoetes made up the majority of the collection in 2011. In addition, the sample counts for Pacific ammocoetes and macrophthalmia at LGR were similar. However, when expanded to a collection, it appears that Pacific macrophthalmia made up the majority of the collection. Some caution is warranted when interpreting collection counts at LGR, as there are many ways for juvenile lamprey to escape the sample tank before being counted. This could lead to underestimates of lamprey collection counts.

Similar to 2011, the 2012 sample and collection data indicate that more larval and juvenile lamprey are being collected at the Lower Columbia sites (BON, JDA, and MCN) than Snake River (LGR, LGS, LMN) sites and Upper Columbia (RIS) sites (Table 1). Also, it appears that sample counts and estimates of collection for Pacific lamprey ammocoetes were lower in 2012 than in 2011 (Table 1). This pattern is true of almost all sites. The mechanism for these decreased ammocoete numbers is currently unknown. It could be an indication of reduced passage of ammocoetes in 2012 or could be a reflection of operational changes in 2012 compared to 2011.

**Table 1.** Total sample and collection counts of larval and juvenile lamprey from the 2011 and 2012 SMP sampling seasons.

Site	Species/Life Stage	2012		2011	
		Sample	Collection	Sample	Collection
BON*	Pacific Ammocoete	21	180	76	729
	Pacific Macrophthalmia	3,157	31,784	2,209	25,412
JDA*	Pacific Ammocoete	172	12,317	1,984	28,215
	Pacific Macrophthalmia	24,531	490,856	10,680	466,479
MCN*	Pacific Ammocoete	2	200	27	1,170
	Unknown Ammocoete	0	0	2	30
	Pacific Macrophthalmia	2,280	242,532	6,567	319,568
RIS	Pacific Ammocoete	8	8	53	54
	Unknown Ammocoete	1	1	1	1
	Pacific Macrophthalmia	126	126	271	272
LMN*	Pacific Ammocoete	7	69	1	1
	Pacific Macrophthalmia	124	2,155	8	1,045
LGS*	Pacific Ammocoete	105	2,553	2,472	6,837
	Pacific Macrophthalmia	404	11,053	320	21,467
LGR	Pacific Ammocoete	63	1,453	372	6,165
	Pacific Macrophthalmia	90	5,557	68	4,420
WTB	Pacific Ammocoete	6	6	0	0

\* Sample and collection counts were extrapolated for non-sample days at these sites.

Extrapolation was based on the previous and subsequent days sample and collection counts. LMN and LGS sampled every 3<sup>rd</sup> or 4<sup>th</sup> day in the early season, MCN had every-other-day sampling from April to July or August, and BON and JDA had some non-sample days late in the season due to temperature protocols.

### *Passage Timing*

By incorporating larval and juvenile lamprey as target species in 2011, actual sample rates can be applied to lamprey sample counts, which allows for the estimation of collection counts. This is particularly important when addressing lamprey passage timing through the hydrosystem, as collection counts are more reliable than sample counts when describing passage timing.

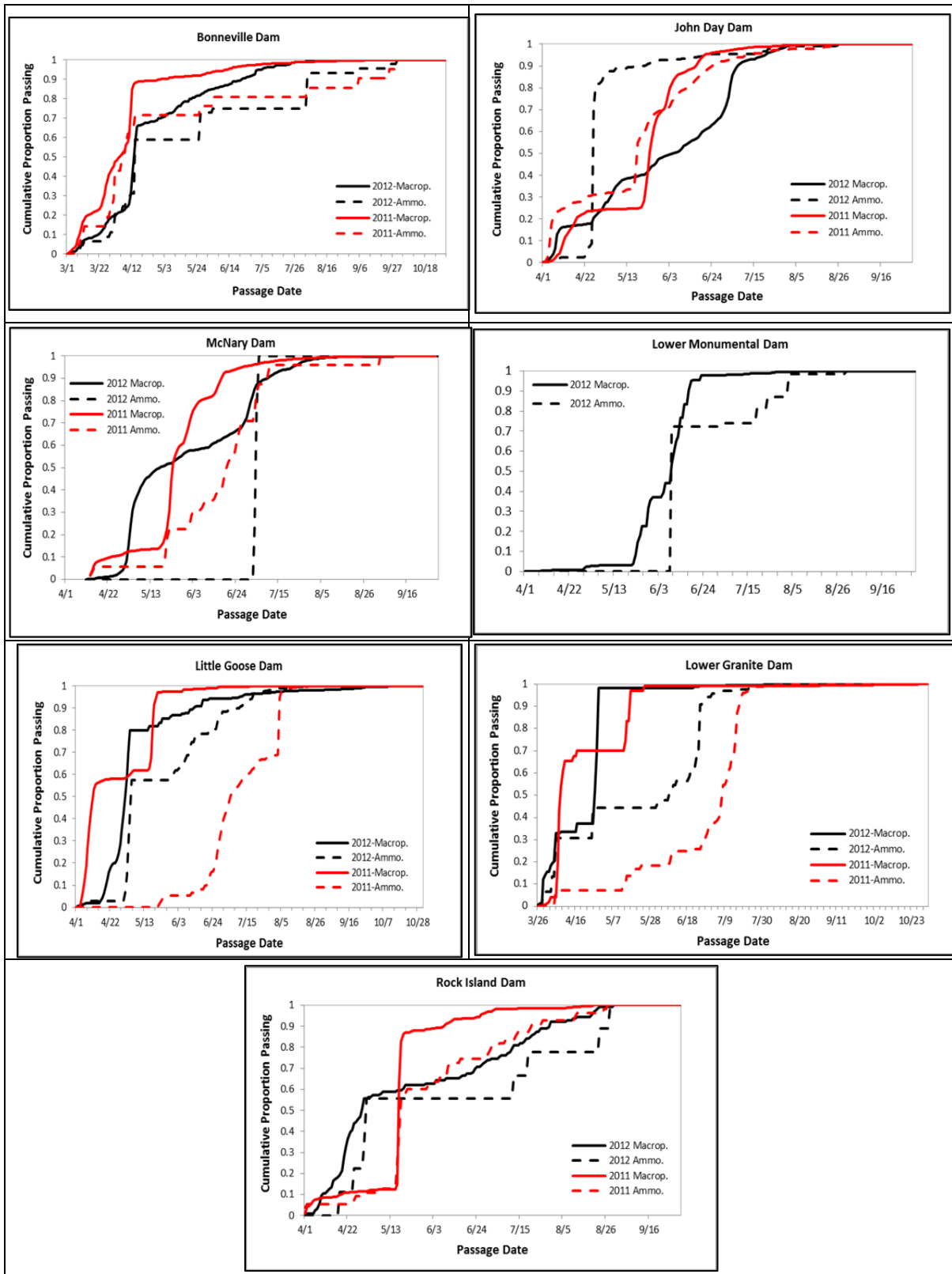
For this report, we estimated passage timing based on the estimated collection counts in 2011 and 2012. Specifically, we estimated the 10%, 50%, and 90% passage dates for Pacific lamprey ammocoetes and macrophthalmia (Table 2). In addition, we provide passage timing curves for all sites in both years except Lower Monumental Dam (LMN) in 2011 (Figure 3). A passage timing curve for LMN in 2011 was not included because larval and juvenile lamprey were only encountered on four separate days and, therefore, there was no separation between the 10%, 50%, and 90% passage dates (Table 2). However, we do provide passage timing curves for LMN in 2012 (Figure 3).

**Table 2.** Estimated 10%, 50%, and 90% passage dates for Pacific lamprey ammocoetes and macrophthalmia in 2011 and 2012, based on collection counts.

Site	Species/Life Stage	2012 Timing			2011 Timing		
		10%	50%	90%	10%	50%	90%
BON	Ammocoetes	29-Mar	14-Apr	3-Aug	9-Apr	29-May	11-Aug
	Macrophthalmia	22-Mar	14-Apr	22-Jun	25-Mar	15-Apr	29-May
JDA	Ammocoetes	26-Apr	26-Apr	22-May	5-Apr	18-May	24-Jun
	Macrophthalmia	5-Jun	5-Jun	7-Jul	24-May	24-May	16-Jun
MCN	Ammocoetes	3-Jul	4-Jul	5-Jul	20-May	20-Jun	10-Jul
	Macrophthalmia	2-May	18-May	10-Jul	23-Apr	24-May	17-Jun
RIS	Ammocoetes	18-Apr	1-May	28-Aug	30-Apr	18-May	21-Jul
	Macrophthalmia	29-Apr	29-Apr	30-Jul	17-May	17-May	8-Jun
LMN	Ammocoetes	9-Jun	9-Jun	3-Aug	26-Aug	26-Aug	26-Aug
	Macrophthalmia	24-May	9-Jun	17-Jun	18-May	19-May	20-May
LGS	Ammocoetes	2-May	5-May	9-Jul	21-Jun	4-Aug	4-Aug
	Macrophthalmia	20-Apr	2-May	12-Jun	6-Apr	12-Apr	19-May
LGR	Ammocoetes	3-Apr	8-Jun	25-Jun	13-May	8-Jul	17-Jul
	Macrophthalmia	29-Mar	27-Apr	29-Apr	6-Apr	8-Apr	17-May

Based on the limited data collected so far, it appears that Pacific macrophthalmia have earlier timing than Pacific ammocoetes. However, the magnitude of this difference seems to vary between years and by site. For example, the difference in timing between Pacific macrophthalmia and Pacific ammocoetes at the Snake River sites was much larger in 2011 than 2012 (Figure 3). The magnitude of the difference at the Lower Columbia and Upper Columbia sites is smaller. Furthermore, lamprey timing at John Day Dam seems to be the opposite, where Pacific ammocoetes arrive earlier than Pacific macrophthalmia (Table 2, Figure 3). This was consistent in both years.

Between-year timing of Pacific lamprey macrophthalmia appears to be fairly consistent at almost all of the sites (Table 2, Figure 3). However, timing of Pacific lamprey macrophthalmia between close sites appears to vary (Table 2, Figure 3). For example, the 50% passage date at BON in 2012 was April 14<sup>th</sup>, whereas that for the JDA was nearly two months later on June 5<sup>th</sup> (Table 2). There appears to be more variability in the between-year timing of Pacific ammocoetes than Pacific macrophthalmia (Figure 2). The difference in timing between two close sites suggests that there may be a strong influence of local lamprey populations, particularly in the Lower Columbia River.



**Figure 3.** Cumulative passage timing curves for Pacific lamprey ammocoetes and macrophthmia at BON, JDA, MCN, LMN, LGS, LGR, and RIS in 2011 and 2012, based on collection counts. Note the x-axes may be different for projects due to different sampling schedules.



## Mortality

We assessed mortality of larval and juvenile lamprey in two ways. First, we estimated a seasonal average mortality for Pacific macrophthalmia and Pacific ammocoetes (where possible). For comparison, we also estimated a seasonal average mortality for yearling Chinook, subyearling Chinook, steelhead, and sockeye. Daily mortality was estimated as the number of sample mortalities divided by the daily sample count. Sample mortalities are those fish that are dead in the sampling tank or GBT fish that die after being sampled at the separator. These mortalities include fish that died prior to being diverted to the sample and that died as a part of the sampling process. When summarizing the daily mortality data, we only included days where a minimum of 20 individuals were sampled. This was done in order to remove days with low sample sizes and, thus, potentially inflated mortality rates. Daily mortality estimates were then weighted based on the daily estimated collection. This weighting allowed us to estimate a weighted average mortality for each species. A weighted average mortality is a more fair representation of the overall seasonal mortality, as it gives more weight to the days where a higher number of juveniles passed, versus giving equal weight to all days. We did this for both 2011 and 2012.

In addition, we constructed histograms of daily sample mortality estimates for the 2012 out-migration season. These histograms were also limited to days where a minimum of 20 individuals were sampled. Similar to 2011, limiting the analyses of mortality to days with a minimum of 20 sampled individuals resulted in only being able to conduct these analyses for the Lower Columbia sites (BON, JDA, and MCN). Furthermore, limited sample counts for Pacific ammocoetes meant that a weighted average mortality estimate was only possible for John Day Dam in 2011. The estimates of the weighted average seasonal mortality rates for the Lower Columbia sites in 2011 and 2012 are provided in Table 3.

**Table 3.** Weighted average mortality (percent) for Pacific macrophthalmia (MP), subyearling Chinook (CH0), yearling Chinook (CH1), sockeye (SO), and steelhead (ST) at Bonneville (BON), John Day (JDA), and McNary (MCN) dams in 2011 and 2012. Minimum and maximum daily mortality rates are provided in parentheses.

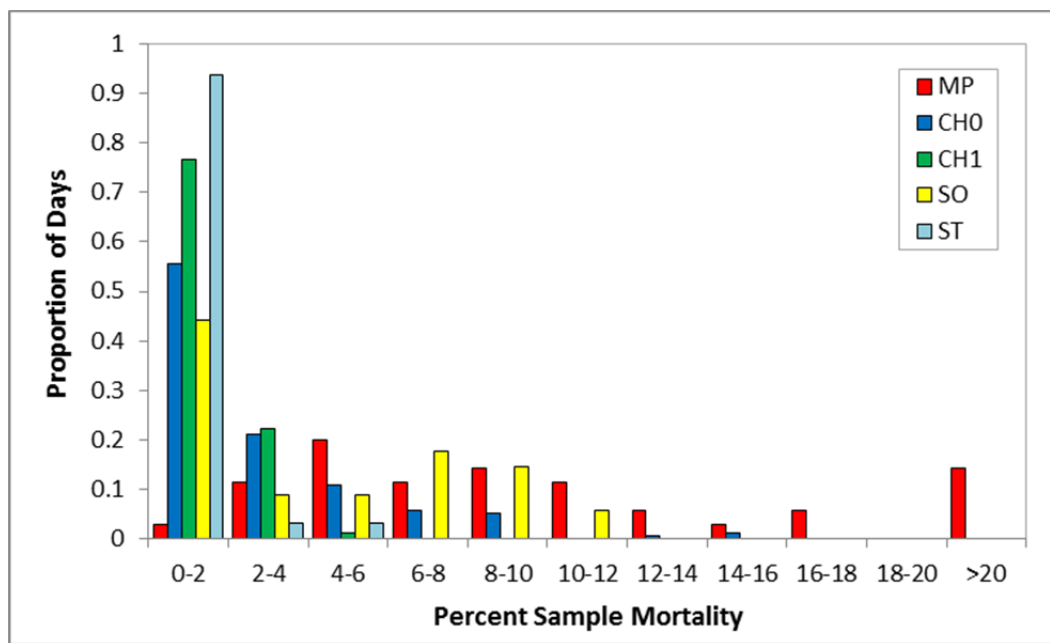
Site	Year	MP	CH0	CH1	SO	ST
BON	2011	8.0 (0.0-30.0)	1.1 (0.0-41.7)	1.0 (0.0-8.5)	2.0 (0.0-9.1)	0.1 (0.0-2.5)
	2012	8.9 (0.0-24.7)	2.6 (0.0-15.4)	1.8 (0.0-4.3)	7.0 (0.0-11.0)	0.3 (0.0-4.8)
JDA	2011	0.4 (0.0-3.3)	0.4 (0.0-4.3)	0.4 (0.0-3.7)	1.6 (0.0-12.5)	0.2 (0.0-4.2)
	2012	0.2 (0.0-3.2)	0.3 (0.0-1.5)	0.3 (0.0-4.0)	1.2 (0.0-8.0)	0.1 (0.0-5.4)
MCN	2011	5.4 (0.0-25)	2.1 (0.0-8.4)	1.3 (0.0-23.1)	1.3 (0.0-14.0)	0.3 (0.0-3.1)
	2012	2.9 (0.0-10.3)	0.9 (0.0-9.4)	0.4 (0.0-2.0)	0.8 (0.0-5.1)	0.4 (0.0-4.5)

\* Due to limited sample counts for Pacific ammocoetes, an estimate of weighted average mortality was only possible for John Day Dam in 2011. The weighted average mortality rate (min and max in parentheses) for Pacific ammocoetes at JDA in 2011 was 0.2% (0.0%-3.0%)

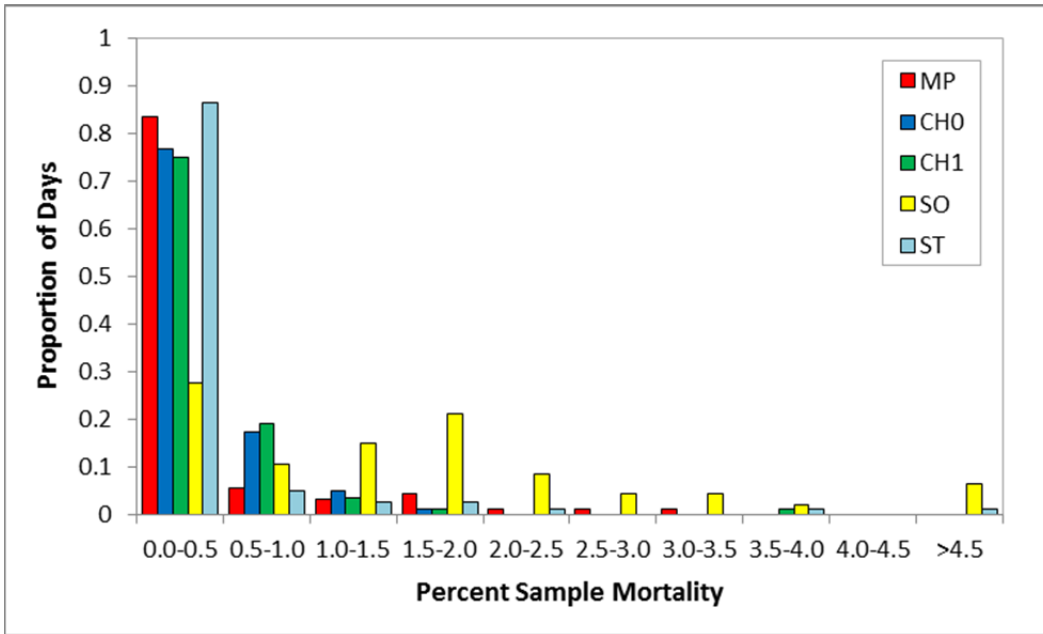
Based on the weighted average mortality estimates, it appears that Pacific macrophthalmia passing through BON and MCN have a higher incidence of mortality than salmonids (Table 3). For example, the weighted average mortality for Pacific macrophthalmia passing through BON in the past two years has ranged from 8.0% to 8.9%, whereas that for salmonids has only ranged from 0.3% to 7.0%. However, Pacific

ammocoetes and Pacific macrophthalmia passing through JDA seem to have similar mortality rates as salmonids (Table 3).

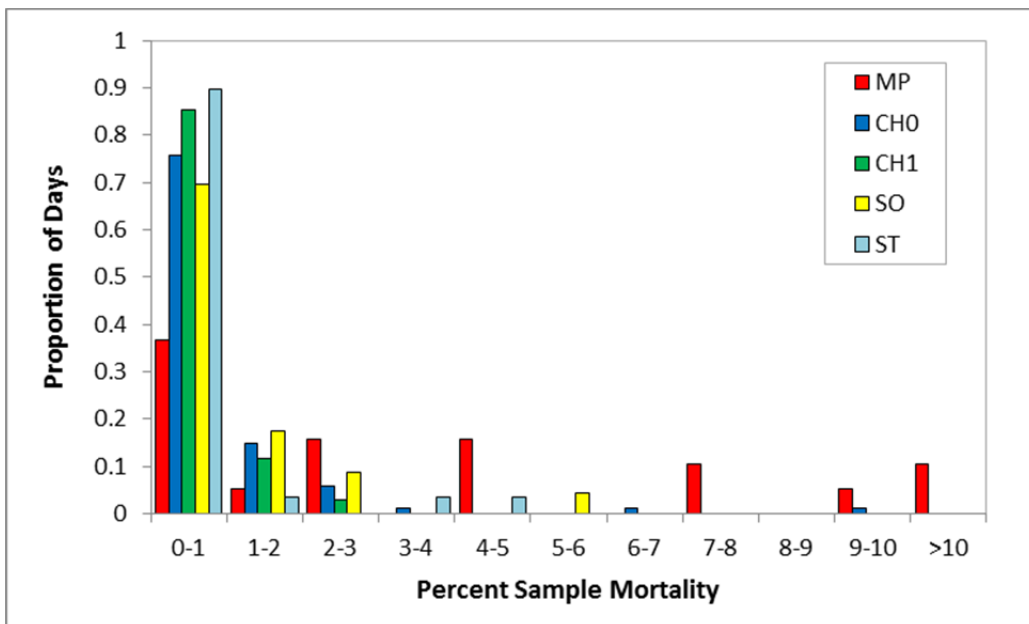
Furthermore, the histograms of 2012 mortality data seem to indicate that high mortality events were more frequent for Pacific macrophthalmia than salmonid juveniles at BON and MCN (Figures 4 and 6, respectively). For example, at Bonneville Dam (Figure 4), mortality percentages for Chinook and steelhead were most often near zero, while mortality percentages for Pacific macrophthalmia varied equally between 2% and 12%. In addition, daily mortalities for Pacific macrophthalmia at BON exceeded 10% in approximately 40% of the days in 2012 (Figure 4). Among salmonids and steelhead, daily mortalities only exceeded 10% for sockeye and subyearling Chinook. Daily mortalities exceeded 10% for only 5.8% of the days for sockeye and 1.7% of the days for subyearling Chinook (Figure 4). At MCN, daily mortalities for Pacific macrophthalmia exceeded 10% for about 10.5% of the days (Figure 6). Daily mortalities for salmonids and steelhead at MCN never exceeded 10% (Figure 6). The frequencies of daily sample mortalities were similar for Pacific macrophthalmia and most salmonids at JDA (Figure 5). At JDA, sockeye smolts seemed to have the highest frequency of high mortality events (Figure 5).



**Figure 4.** Frequency histogram of sample mortalities for Pacific macrophthalmia (MP), subyearling Chinook (CH0), yearling Chinook (CH1), sockeye (SO), and steelhead (ST) at Bonneville Dam in 2012.



**Figure 5.** Frequency histogram of sample mortalities for Pacific macrophthalmia (MP), subyearling Chinook (CH0), yearling Chinook (CH1), sockeye (SO), and steelhead (ST) at John Day Dam in 2012.



**Figure 6.** Frequency histogram of sample mortalities for Pacific macrophthalmia (MP), subyearling Chinook (CH0), yearling Chinook (CH1), sockeye (SO), and steelhead (ST) at McNary Dam in 2012.

## ***Lamprey Condition Monitoring at John Day, McNary, and Bonneville Dams***

### ***Introduction***

In 2011, a pilot study was carried out by the SMP at the John Day Dam Smolt Monitoring Facility to gather information on the condition of out-migrating, bypassed juvenile Pacific lamprey (*Entosphenus tridentatus*). Condition exam results represent a combination of in-river baseline conditions such as disease and predation marks and also provide data about injuries incurred while passing through the bypass systems and other routes at the dam(s) as well as injuries that may have occurred due to encounters with predators. Based on information gathered in 2011, the FPC staff and staff from JDA developed a handling and condition sampling protocol for future monitoring efforts. After the 2011 pilot study it was determined that lamprey condition monitoring would be expanded to the other sites on the Lower Columbia River (BON, JDA, and MCN), as these were the only sites with high enough sample counts to warrant condition monitoring. All sites conducting lamprey condition monitoring in 2012 were provided copies of the new Lamprey Condition Monitoring Protocol, which is available on the FPC website: [ftp://ftp.fpc.org/FPC32.net/Manuals/ConditionSamplingProtocol\\_2012.pdf](ftp://ftp.fpc.org/FPC32.net/Manuals/ConditionSamplingProtocol_2012.pdf).

### ***Lamprey Condition Results***

#### ***Sample Numbers***

In 2012, JDA sampled a total of 172 Pacific ammocoetes and 24,531 Pacific macrophthalmia (Table 1). Of these, a subsample of 165 ammocoetes (95.9%) and 7,136 macrophthalmia (29.1%) were examined for condition. At BON, the total sample for Pacific ammocoetes was 21 and the total sample for Pacific macrophthalmia was 3,157 (Table 1). For condition monitoring, BON examined a subsample of 18 Pacific ammocoetes (85.7%) and 2,291 Pacific macrophthalmia (72.6%). Finally, the total sample of Pacific ammocoetes and Pacific macrophthalmia at MCN was 2 and 2,280, respectively (Table 1). Of these, only one Pacific ammocoete and 941 Pacific macrophthalmia (41.3%) were examined for condition.

#### ***Length and Weight***

At BON, Pacific ammocoetes in 2012 were smaller in length and lighter in weight than Pacific macrophthalmia (Table 4). However, at JDA Pacific ammocoetes and Pacific macrophthalmia were similar in lengths (Table 4). There appears to be a larger difference in weights between Pacific ammocoetes and Pacific macrophthalmia where ammocoetes are heavier than macrophthalmia (Table 4). This was the case in both 2011 and 2012, at about the same magnitude. Finally, only one Pacific ammocoete was examined for condition at MCN. Therefore, we do not have an estimate of average length or weight for this individual. The average length and weight of Pacific macrophthalmia at MCN was 142.0 mm TL and 3.9 grams, which are slightly lower than the respective lengths and weights at BON and JDA (Table 4). Finally, Pacific ammocoetes at BON were smaller in length and weight than those at JDA (Table 4). As with timing, this may indicate a large influence of local populations, particularly at BON.

**Table 4.** Average length (mm TL) and weight (g) of Pacific ammocoetes and Pacific macrophthalmia sampled for condition monitoring at BON, JDA, and MCN in 2011. Numbers in parentheses are 95% confidence intervals.

Site	Migration Year	Ammocoetes		Macrophthalmia	
		Length (mm)	Weight (g)	Length (mm)	Weight (g)
BON	2012	109.7 (94.6-124.8)	2.7 (1.2-4.3)	144.6 (144.0-145.1)	4.3 (4.2-4.3)
JDA	2011	145.6 (145.0-146.2)	5.2 (5.1-5.3)	143.3 (143.0-143.6)	4.2 (4.1-4.3)
	2012	145.4 (144.0-146.7)	5.1 (5.0-5.3)	144.9 (144.7-145.1)	4.3 (4.3-4.3)
MCN	2012	N/A	N/A	142.0 (141.4-142.7)	3.9 (3.9-4.0)

#### *Disease and Injury Results*

Most of the photographs that were provided to the LTWG in the Lamprey Report for 2011 (<http://www.fpc.org/documents/memos/169-11.pdf>) were incorporated into the Lamprey Condition Monitoring Protocol. Therefore, we have left them out of this year's report. A summary of the condition exam results for Pacific ammocoetes (AP) and macrophthalmia (MP) in 2011 and 2012 can be found in Tables 5-7.

#### *Injuries and Predation*

In 2011, body injuries and fin injuries were the most common type of injury observed in the condition monitoring program at JDA, for both life stages of lamprey (Table 5). In 2012, the most common type of injury observed on Pacific ammocoetes was body injury (Table 5). For Pacific macrophthalmia, the most common injuries encountered at JDA in 2012 were bird marks and fin injuries (Table 5). At BON and MCN, the most common injuries for Pacific ammocoetes were body injuries, whereas bird marks, body injuries, and fin injuries were the most prevalent injuries for Pacific macrophthalmia (Table 5). Head injuries among Pacific macrophthalmia were also relatively high at MCN in 2012 (Table 5).

It is important to note that the apparent drop in body injuries at JDA between 2011 and 2012 is largely due to a change in the way body injuries were being "called" in 2012, compared to 2011. In April of 2012, the FPC provided clarification that "injuries" were only to be recorded for instances that could not be clearly attributed to disease, parasites, and/or predators. Many of the marks that were recorded as "injuries" in 2011 were consistent with bird marks. Therefore, in 2012, marks that were thought to be consistent with bird marks were recorded as Predator Bird, instead of body injury. Given this confusion, FPC staff will be working with the USFWS staff and SMP personnel in 2013 to develop a protocol on distinguishing between true injuries that are caused by the bypass system at the projects and those that may be attributable to predators.

**Table 5.** Summary of Pacific lamprey injury and predator marks at John Day (JDA), McNary (MCN), and Bonneville (BON) in 2011 and 2012.

<b>Species</b>	<b>Injury</b>	<b>JDA – 2011*</b>	<b>JDA – 2012*</b>	<b>MCN - 2012</b>	<b>BON - 2012</b>
Pacific Ammo.	Number Examined	851	165	1	18
	Body Injury	5.3%	7.9%		5.6%
	Eye Injury	0.0%	0.0%		0.0%
	Head Injury	0.7%	0.0%		0.0%
	Fin Injury	0.9%	0.6%		0.0%
	Predation-Bird	0.0%	0.0%		0.0%
Pacific Macrop.	Number Examined	4,245	7,136	941	2,291
	Body Injury	6.1%	0.8%	2.8%	2.9%
	Eye Injury	0.2%	0.1%	0.0%	0.0%
	Head Injury	0.5%	0.5%	1.1%	0.3%
	Fin Injury	5.8%	1.4%	1.9%	3.4%
	Predation-Bird	0.0%	8.3%	5.4%	3.7%
Total Lamprey	Number Examined	5,096	7,301	942	2,309
	Body Injury	5.9%	1.0%	2.9%	2.9%
	Eye Injury	0.2%	0.1%	0.0%	0.0%
	Head Injury	0.6%	0.5%	1.2%	0.3%
	Fin Injury	5.0%	1.4%	1.9%	3.4%
	Predation-Bird	0.0%	8.1%	5.4%	3.6%

\*In 2012, FPC provided clarification that “injuries” are only recorded for instances that cannot be clearly attributable to disease, predator, or parasite. Pilot monitoring program at JDA in 2011 may have entered suspected “predator marks” as injuries.

### *Hemorrhaging*

Signs of eye and fin hemorrhaging were noted on both ammocoetes and macrophthalmia. In general, signs of fin hemorrhaging were only found in about 1-2% of the ammocoetes and macrophthalmia that were examined at JDA and MCN (Table 6). Eye hemorrhaging was even less common at these sites. Signs of fin hemorrhaging were much more common at BON. In fact, nearly 7% of all lamprey juveniles that were examined for condition monitoring at BON showed signs of fin hemorrhaging (Table 6). Eye hemorrhaging was much less common at BON and more comparable to the other two sites.

**Table 6.** Summary of Pacific lamprey hemorrhaging at John Day (JDA), McNary (MCN), and Bonneville (BON) in 2011 and 2012.

Species	Hemorrhage Type	JDA - 2011	JDA - 2012	MCN - 2012	BON - 2012
Pacific Ammo.	Number Examined	851	165	1	18
	Eye Hemorrhage	0.1%	0.0%		0.0%
	Fin Hemorrhage	1.3%	0.6%		11.1%
Pacific Macrop.	Number Examined	4,245	7,136	941	2,291
	Eye Hemorrhage	0.0%	0.1%	0.0%	0.2%
	Fin Hemorrhage	1.1%	1.1%	1.9%	6.8%
Total Lamprey	Number Examined	5,096	7,301	942	2,309
	Eye Hemorrhage	0.1%	0.1%	0.0%	0.2%
	Fin Hemorrhage	1.2%	1.1%	1.9%	6.8%

### *Diseases*

For both 2011 and 2012, observations of external disease were only observed on Pacific macrophthalmia but were very rare (Table 7). Fungus was the most common disease observed on Pacific macrophthalmia. For 2012, fungus was observed in 1.2% of the macrophthalmia at JDA, 0.1% at MCN, and 0.2% at BON (Table 7). Deformities were also observed in Pacific macrophthalmia in 2012, but only at JDA.

**Table 7.** Summary of Pacific lamprey disease at John Day (JDA), McNary (MCN), and Bonneville (BON) in 2011 and 2012.

Species	Disease	JDA - 2011	JDA - 2012	MCN - 2012	BON - 2012
Pacific Ammo.	Number Examined	851	165	1	18
	Columnaris	0.0%	0.0%		0.0%
	Fungus	0.0%	0.0%		0.0%
	Deformity	0.0%	0.0%		0.0%
Pacific Macrop.	Number Examined	4,245	7,136	941	2,291
	Columnaris	0.0%	0.0%	0.0%	0.0%
	Fungus	0.2%	1.2%	0.1%	0.2%
	Deformity	0.0%	0.1%	0.0%	0.0%
Total Lamprey	Number Examined	5,096	7,301	942	2,309
	Columnaris	0.0%	0.0%	0.0%	0.0%
	Fungus	0.2%	1.2%	0.1%	0.2%
	Deformity	0.0%	0.1%	0.0%	0.0%