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MEMORANDUM

TO: Christina Wang (USFWS)
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Joe Skalicky (USFWS)
Brian McIlraith (CRITFC)

FROM: Brandon Chockley

DATE: November 12, 2014

RE: Results of 2014 Lamprey Monitoring

In accordance with the Fish Passage Center (FPC) contract, FPC staff has summarized the lamprey monitoring data that were gathered as part of the Smolt Monitoring Program (SMP) in 2014. Migration year 2014 is the fourth year of including lamprey as target species in the SMP. Thus, we are providing a summary of the results from 2011 through 2014. Below is a brief summary of our findings from these analyses, followed by a more detailed description of the analyses we conducted.

- There were no major issues with lamprey data collection in 2014.
- Lamprey condition monitoring at the Lower Columbia sites (BON, JDA, and MCN) was successful in 2014.
    - SMP personnel provided more detailed pictures to enhance the lamprey condition monitoring protocol for future years. FPC and USFWS staff will incorporate these pictures into the 2015 monitoring program.
- Sample counts at the Snake River and Upper Columbia River SMP sites were relatively low. At this time the FPC still does not recommend that lamprey condition monitoring be expanded to any of these sites.

- A PIT-tag study at LGR in 2013 confirmed that Pacific macropthalmia are escaping the sample tank before being counted. Given this, the Fish Passage Advisory Committee (FPAC) determined that collection estimates for larval and juvenile lamprey at LGR will no longer be reported.
- It appears that Pacific macropthalmia at BON, MCN, and LGS consistently have a higher weighted average mortality rate than all species of salmonids at these sites.

Background

In 2010 the FPC was requested to expand and standardize the collection of lamprey data for the SMP. The Lamprey Technical Work Group (LTWG) chair met with FPC staff and together developed a list of changes to lamprey monitoring that would address critical needs. Changes to lamprey data collection through the SMP included: (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 FPAC the FPC adopted and implemented these changes to the SMP in 2011 for all sites, except the Imnaha Trap, which implemented these changes in 2013.

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). Since the original report in 2011, the FPC has prepared similar reports for the LTWG on an annual basis, which are available on the FPC website (http://www.fpc.org/documents/FPC_memos.html). 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 Independent Science Advisory Board (ISAB), the FPC added lamprey data to the 2011 FPC Annual Report and has included these data in subsequent annual reports, which are also available on the FPC website (http://www.fpc.org/documents/FPC_Annual_Reports.html).

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

Therefore, 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 in 2012. Migration year 2014 is the third year of the expanded condition monitoring program for lamprey juveniles.

Methods

Lamprey Identification

As in past years, larval and juvenile lamprey were identified using guidelines developed by USFWS. 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).

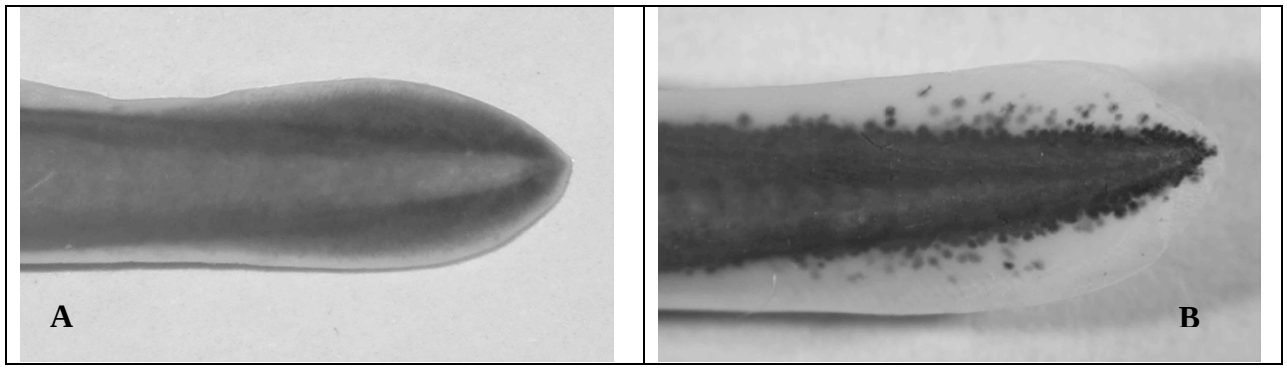

Figure 1. Comparison of caudal region of *Entosphenus tridentatus* (A) and *Lampetra spp* (B) ammocoete from USFWS lamprey identification guide used by the Smolt Monitoring Program.

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.

Since Western Brook lamprey do not exhibit a macropthalmia (or juvenile) life stage the macropthalmia designation was used for lamprey identified as Pacific lamprey. Macropthalmia 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 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 (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).

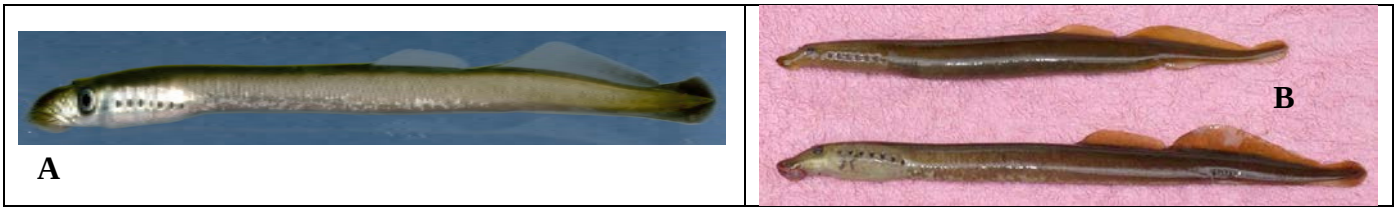

Figure 2. Comparison of the relative eye size of Pacific lamprey macrothalmia (A) and Western Brook lamprey adults (B). Figure from the USFWS key to lamprey identification used by the SMP.

In addition, adult lamprey collected in the SMP samples were identified using USFWS pamphlets as well as the guide book *Inland Fishes of Washington* (Wydoski and Whitney 2003). Adult lamprey continue to be recorded as incidental species.

Lamprey Counts, Passage Timing, and Mortality

In 2014, the SMP continued to use the data entry procedure initiated in 2011. This data entry procedure allowed larval and juvenile lamprey sample data to be directly related to sample rates used in fish collection. Prior to 2011, SMP personnel 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, an estimation of collection (i.e., abundance estimate of individuals passing through the juvenile bypass system) was not possible. Under the new procedures adopted in 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 at (ftp://ftp.fpc.org/FPC32.net/Manuals/ConditionSamplingProtocol_2014a.pdf). At the request of the LTWG, lamprey condition monitoring was expanded to Bonneville Dam, John Day Dam, and McNary Dam in 2012, and has continued since. All three of these sites followed the above mentioned lamprey monitoring protocol in 2014.

Results

Lamprey Counts, Passage Timing, and Mortality (2011–2014)

Larval and Juvenile Lamprey Counts

As mentioned above, lamprey juveniles have been recorded as target species and have been identified to life-stage and species at all SMP sites since 2011, except the Imnaha River Trap. However, the Imnaha River Trap began using the same lamprey sampling protocol for the 2013 season. The four life-stage/species combinations for lamprey juveniles were: (1) Pacific Macropthalmia (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.

Below is a summary of the sample and collection counts that were recorded in 2014 at each of the SMP sites, as well as the sample and collection counts from 2011 through 2013 (Table 1 and Table 2). In 2013, a study was conducted at Lower Granite Dam to evaluate the prototype juvenile fish collection channel overflow weir and enlarged orifice. This study involved PIT-tagging juvenile salmonids and Pacific lamprey macropthalmia and releasing these PIT-tagged fish into gatewell 5A, 5B, or directly into the orifice gallery channel. The study confirmed that juvenile lamprey can escape the sample tank at LGR prior to being sampled. Consequently, the Fish Passage Advisory Committee recommended that only sample counts would be reported for this site until escapement is remedied. (It is worth noting that even sample counts for lamprey at LGR are likely biased low.)

In the four years of sampling, Pacific lamprey macropthalmia collection estimates comprised the majority of the lamprey samples at SMP Dam sampling sites (Table 1). Additionally, no brook lamprey have been collected at any of the SMP dam facilities since this sampling protocol began in 2011.

Table 1. Total sample counts and estimates of collection of larval and juvenile lamprey at dams from the 2011–2014 SMP sampling seasons.

		Sample Counts				Collection Estimates			
Site	**Species/Life Stage**	**2011**	**2012**	**2013**	**2014**	**2011**	**2012**	**2013**	**2014**
BON*	Pacific Ammocoete	76	21	14	6	729	180	100	58
	Unknown Ammocoete	0	0	0	2	0	0	0	13
	Pacific Macropthalmia	2,209	3,157	503	1,741	25,412	31,784	6,257	19,510
JDA*	Pacific Ammocoete	1,984	172	21	86	28,215	12,317	217	1,131
	Pacific Macropthalmia	10,680	24,531	4,894	4,163	466,479	490,856	175,931	97,845
MCN*	Pacific Ammocoete	27	2	0	2	1,170	200	0	200
	Unknown Ammocoete	2	0	0	0	30	0	0	0
	Pacific Macropthalmia	6,567	2,280	2,995	2,004	319,568	242,532	176,398	121,221
RIS*	Pacific Ammocoete	53	8	9	36	54	8	9	36
	Unknown Ammocoete	1	1	0	0	1	1	0	0
	Pacific Macropthalmia	271	126	178	184	272	126	178	184
LMN*	Pacific Ammocoete	1	7	3	1	1	69	3	4
	Pacific Macropthalmia	8	124	904	453	1,045	2,155	63,854	29,559
	Unknown Lamprey	0	0	3	0	0	0	3	0
LGS*	Pacific Ammocoete	2,472	105	30	52	6,837	2,553	605	2,475
	Unknown Ammocoete	0	0	0	2	0	0	0	20
	Pacific Macropthalmia	320	404	1,389	624	21,467	11,053	57,383	19,321
LGR†	Pacific Ammocoete	372	63	15	79	N/A	N/A	N/A	N/A
	Pacific Macropthalmia	68	90	73	114	N/A	N/A	N/A	N/A

* Sample counts and collection estimates 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 typically sample every 3rd or 4th day from early April to early/mid-May; MCN has every-other-day sampling; and BON and JDA often have non-sample days in August and/or September due to high temperature sampling protocols. RIS missed a few samples in July of 2013 due to mechanical issues.

† Due to escapement of juvenile lamprey from the sample tank at LGR, estimates of sample are biased low and unreliable. Therefore, estimation of collection is not possible for this site.

Table 2. Total sample counts of larval and juvenile lamprey at SMP traps from the 2011–2014 SMP sampling seasons. SMP Trap site codes are as follows: (1) Salmon River Trap at Whitebird, ID (WTB), and (2) Imnaha River Trap (IMN).

Site	**Species/Life Stage**	**2011**	**2012**	**2013**	**2014**
WTB	Pacific Ammocoete	0	6	0	0
	Pacific Macropthalmia	0	0	0	1
IMN*	Pacific Ammocoete	N/A	N/A	6	3
	Pacific Macropthalmia	N/A	N/A	2	0

* Lamprey sampling protocol was not implemented at the Imnaha Trap until 2013.

Although larval and juvenile lamprey are target species at all SMP sites, the SMP traps collect very few lamprey juveniles. In fact, only two SMP traps (Imnaha Trap and Salmon River Trap at Whitebird) have ever collected lamprey juveniles since the new lamprey sampling protocol was implemented (Table 2).

Passage Timing

By incorporating larval and juvenile lamprey as target species in 2011, actual sample rates can be applied to lamprey sample counts, which allow for the estimation of collection counts (except at LGR). 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 estimate passage timing based on the estimated collection counts in 2011–2014. Specifically, we estimate the 10%, 50%, and 90% passage dates for Pacific lamprey ammocoetes and macropthalmia (Table 3). In addition, we provide passage timing curves for both life-stages across all four years at all sites (Figure 3 for Pacific macropthalmia and Figure 4 for Pacific ammocoetes).

Table 3. Estimated 10%, 50%, and 90% passage dates for Pacific lamprey ammocoetes and macropthalmia at SMP dams in 2011–2014, based on estimated collection counts (except at LGR).

Site	Species/Life Stage	2011 Timing			2012 Timing			2013 Timing			2014 Timing		
		10%	50%	90%	10%	50%	90%	10%	50%	90%	10%	50%	90%
BON	Ammocoetes	4/9	5/29	8/11	3/29	4/14	8/3	3/22	5/29	8/12	6/20	6/23	9/3
	Macropthalmia	3/25	4/15	5/29	3/22	4/14	6/22	3/24	6/4	7/17	3/18	4/10	7/7
JDA	Ammocoetes	4/5	5/18	6/24	4/26	4/26	5/22	4/5	4/14	5/22	4/3	4/25	6/27
	Macropthalmia	4/12	5/24	6/16	4/8	6/5	7/7	4/20	5/26	7/5	4/28	6/3	6/29
MCN	Macropthalmia	4/23	5/24	6/17	5/2	5/18	7/10	5/15	5/25	8/20	6/2	6/20	7/14
RIS	Ammocoetes	4/30	5/18	7/21	4/18	5/1	8/28	4/7	5/16	7/5	8/14	8/14	8/27
	Macropthalmia	4/19	5/17	6/8	4/10	4/29	7/30	4/11	6/27	8/13	5/21	8/16	8/27
LMN	Macropthalmia	5/18	5/19	5/20	5/24	6/9	6/17	5/15	5/17	5/22	5/25	5/29	6/3
LGS	Ammocoetes	6/21	7/5	8/4	5/2	5/5	7/9	4/14	5/21	7/11	5/30	6/12	6/21
	Macropthalmia	4/6	4/12	5/19	4/20	5/2	6/12	5/15	5/17	5/20	5/19	5/31	6/20

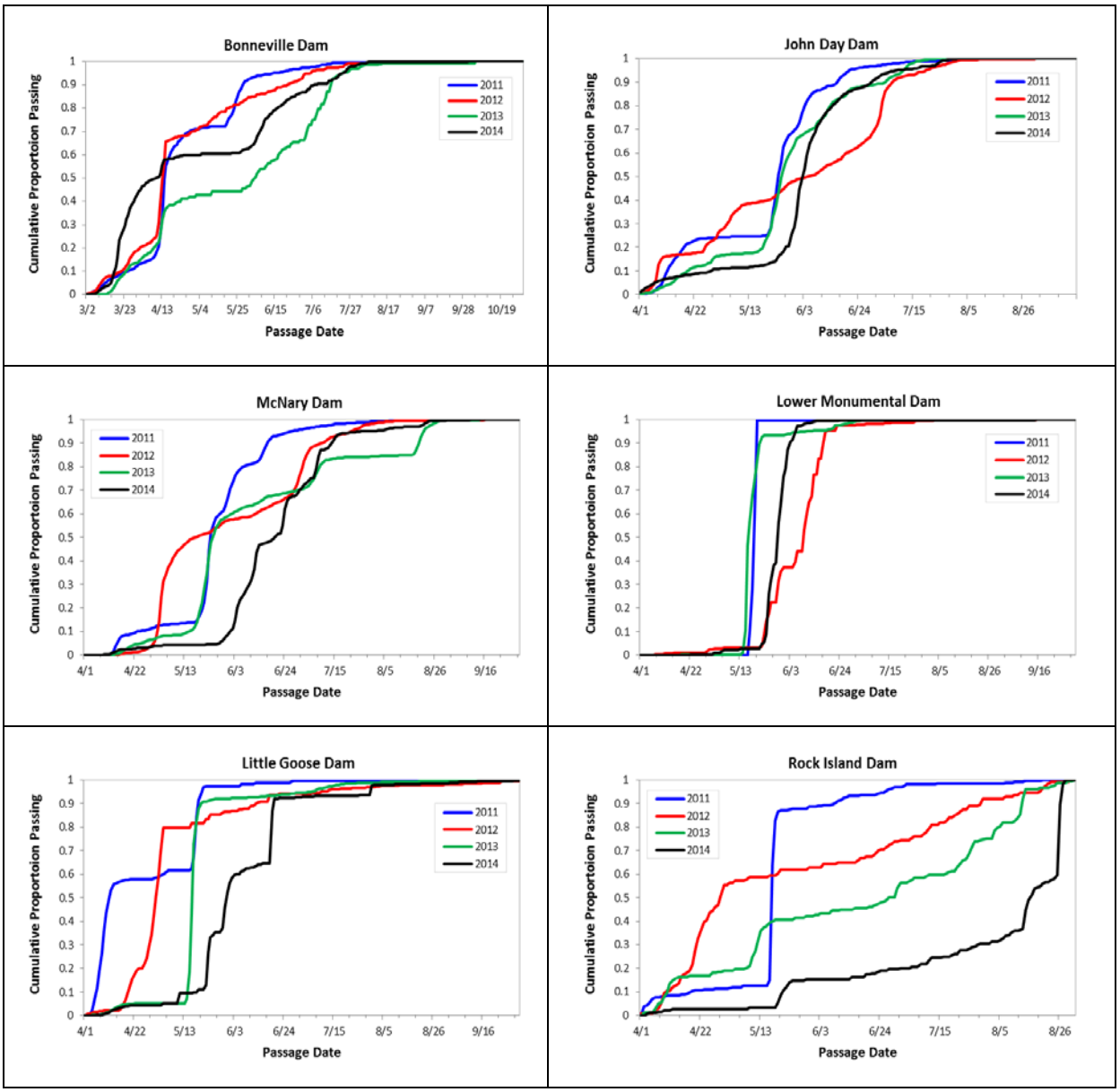

Figure 3. Cumulative passage timing curves for Pacific lamprey macropthalmia at BON, JDA, MCN, LMN, LGS, and RIS in 2011–2014, based on estimated collections. Note the x-axis may be different for projects due to different sampling schedules.

Due to infrequent encounters at LMN and MCN, estimating passage timing for Pacific ammocoetes was not possible. Therefore, we do not present timing estimates for Pacific ammocoetes at these sites. Furthermore, since we no longer estimate collections at LGR, we do not present estimates of timing for this site.

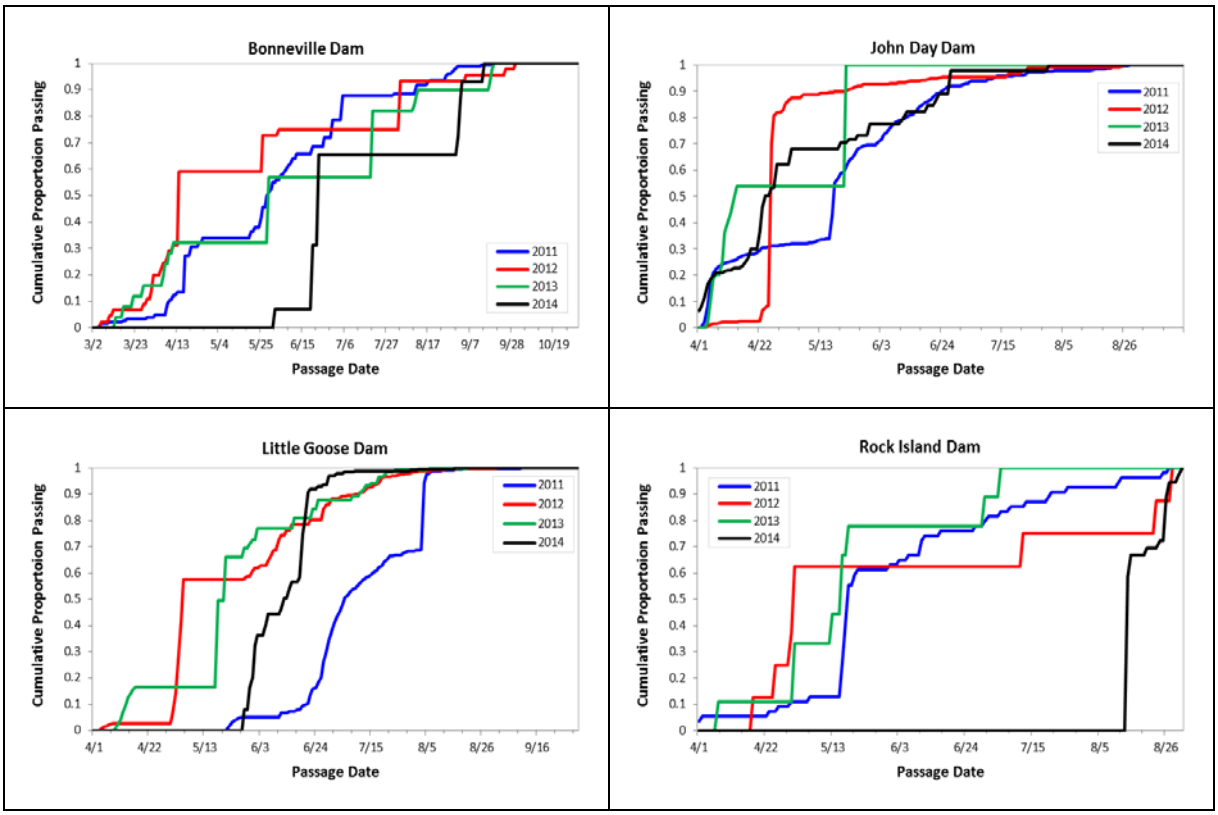

Figure 4. Cumulative passage timing curves for Pacific lamprey ammocoetes at BON, JDA, LGS, and RIS in 2011–2014, based on estimated collections.

Mortality

We assessed the sample mortality of larval and juvenile lamprey in two ways. First, we estimated a seasonal average mortality for Pacific macropthalmia 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 included days only 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. For all sites except LGR, daily mortality estimates were then weighted based on the daily estimated collection. Due to the inability to estimate lamprey collections at LGR, we were unable to estimate a seasonal average mortality. 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 all 4 years (2011–2014).

In addition, we constructed histograms of daily sample mortality estimates for the 2014 juvenile migration season. These histograms were also limited to days where a minimum of 20 individuals were sampled. In general, limiting the analyses of mortality to days with a minimum

of 20 sampled individuals resulted in being able to conduct these analyses only for the Lower Columbia sites (BON, JDA, and MCN) in 2011 and 2012. However, for 2013 and 2014, there were two Snake River sites (LGS and LMN) that had several days where a minimum of 20 individuals were sampled. Furthermore, limited sample counts for Pacific ammocoetes meant that a weighted average mortality estimate was possible only for JDA and LGS in 2011. The 2011 weighted average mortality rates (minimum and maximum in parentheses) for Pacific ammocoetes at these sites were: (1) JDA – 0.2% (0.0%–3.0%) and (2) LGS - 0.2% (0.0–1.9%). The estimates of the weighted average seasonal mortality rates for Pacific macropthalmia and target salmonids in 2011–2014 are provided in Table 4.

Table 4. Weighted average mortality (percent) for Pacific macropthalmia (MP), subyearling Chinook (CH0), yearling Chinook (CH1), sockeye (SO), and steelhead (ST) at Bonneville (BON), John Day (JDA), McNary (MCN), Little Goose (LGS), and Lower Monumental (LMN) dams in 2011–2014. 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)
	2013	4.7 (0.0-9.5)	0.8 (0.0-8.9)	0.5 (0.0-4.8)	1.1 (0.0-4.1)	0.3 (0.0-5.0)
	2014	5.8 (0.0-17.5)	1.4 (0.0-25.0)	0.3 (0.0-8.5)	1.8 (0.0-9.4)	0.1 (0.0-4.5)
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)
	2013	0.0 (0.0-0.9)	0.3 (0.0-2.2)	0.3 (0.0-2.9)	0.4 (0.0-1.9)	0.2 (0.0-4.1)
	2014	0.4 (0.0-2.7)	0.8 (0.0-6.1)	0.2 (0.0-3.7)	0.6 (0.0-5.0)	0.2 (0.0-4.0)
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)
	2013	1.5 (0.0-14.3)	1.4 (0.0-5.2)	0.7 (0.0-2.2)	1.4 (0.0-8.7)	0.1 (0.0-4.3)
	2014	3.2 (0.0-9.1)	1.3 (0.0-5.0)	0.8 (0.0-6.5)	0.9 (0.0-7.7)	0.2 (0.0-1.7)
LGS	2013	1.9 (0.0-7.4)	0.3 (0.0-13.6)	0.1 (0.0-5.9)		0.1 (0.0-1.0)
	2014	1.9 (0.0-5.0)	0.4 (0.0-13.2)	0.2 (0.0-3.7)	0.1 (0.0-6.9)	0.1 (0.0-3.2)
LMN	2013	1.7 (0.0-75.0)	0.5 (0.0-34.3)	0.3 (0.0-4.5)		0.2 (0.0-7.1)
	2014	0.0 (0.0-0.0)	0.2 (0.0-24.7)	0.3 (0.0-1.3)	0.0 (0.0-0.0)	0.3 (0.0-3.6)

It appears that Pacific macropthalmia at BON and MCN consistently have a higher weighted average mortality rate than all species of salmonids at these sites (Table 4). The one exception to this pattern was in 2013 at MCN, where Pacific macropthalmia had similar mortality rates as subyearling Chinook and sockeye, which were among the highest of all species in that year (Table 4). In addition, for the two years where data are available, Pacific macropthalmia at LGS also had higher weighted average mortality rates than did all species of salmonids (Table 4). Finally, as in previous years, Pacific macropthalmia passing through JDA in 2014 seemed to have similar weighted average mortality rates as salmonids (Table 4).

In previous years, histograms of mortality data seemed to indicate that high mortality events were more frequent for Pacific macropthalmia than salmonid juveniles at BON and MCN (see FPC memos from Nov. 22, 2011, Nov. 14, 2012, and Dec. 3, 2013). This pattern appears to have continued at these two sites in 2014 (Figures 5 and 6). For example, at MCN, daily mortalities for Pacific macropthalmia were above 6% for about 25% of the days and exceeded

9% for about 8% of the days (Figure 6). Daily mortalities for salmonids and steelhead at MCN never exceeded 9% and were above 6% only for yearling Chinook (3.2% of the days) and sockeye (4% of the days) (Figure 6). This pattern of more frequent high mortality events for Pacific macropthalmia than for salmonids was not observed at the other sites where these comparisons were possible (Figures 7–9).

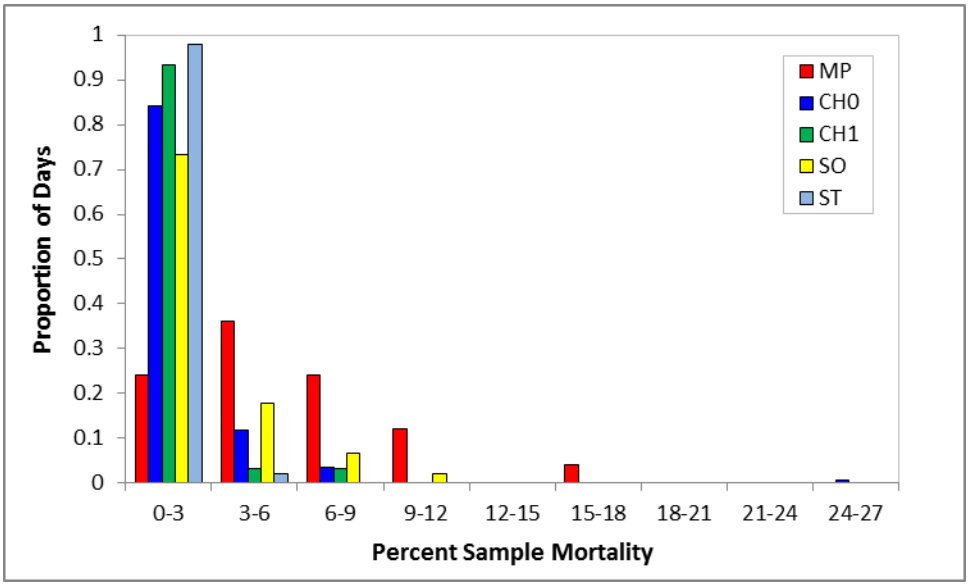

Figure 5. Frequency histogram of sample mortalities for Pacific macropthalmia (MP), subyearling Chinook (CH0), yearling Chinook (CH1), sockeye (SO), and steelhead (ST) at Bonneville Dam in 2014.

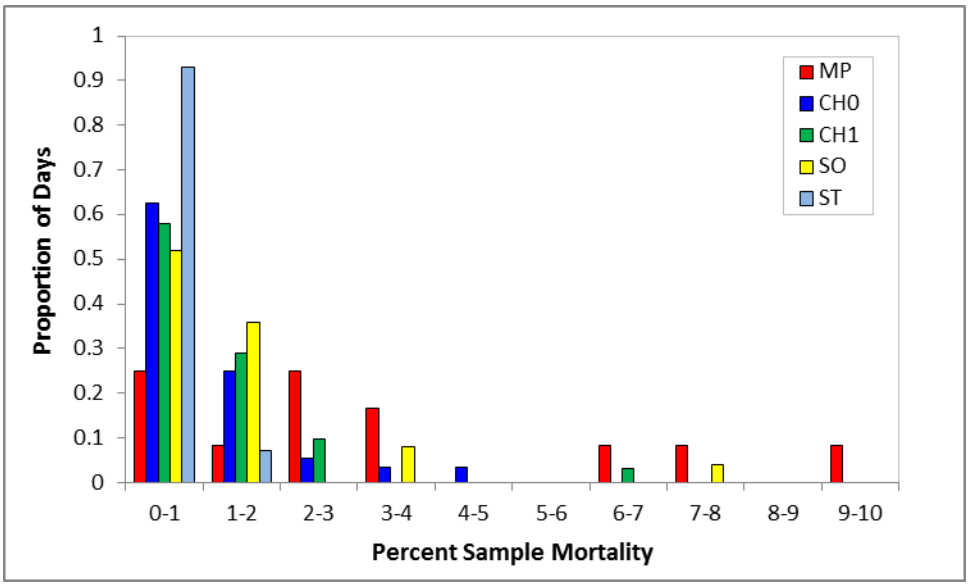

Figure 6. Frequency histogram of sample mortalities for Pacific macropthalmia (MP), subyearling Chinook (CH0), yearling Chinook (CH1), sockeye (SO), and steelhead (ST) at McNary Dam in 2014.

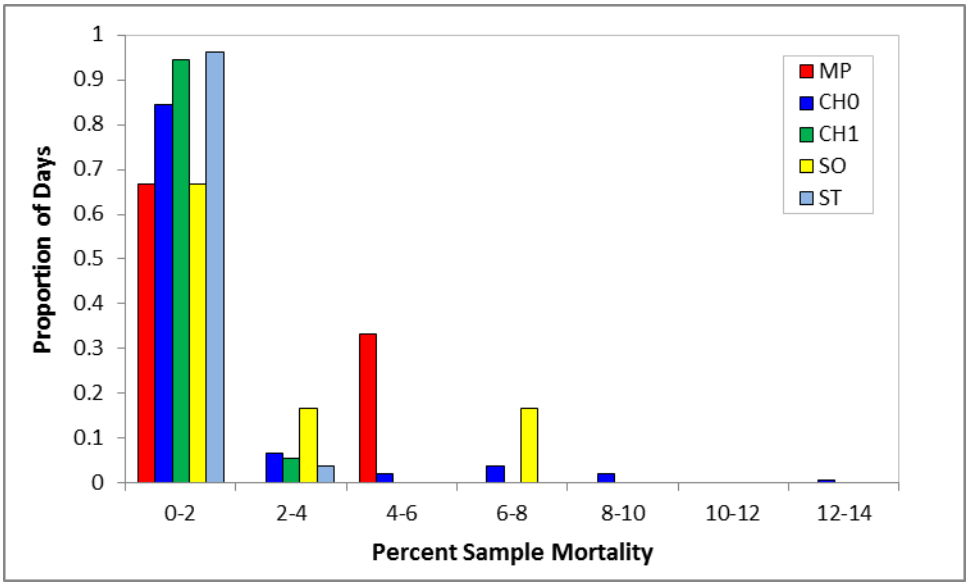

Figure 7. Frequency histogram of sample mortalities for Pacific macropthalmia (MP), subyearling Chinook (CH0), yearling Chinook (CH1), and steelhead (ST) at Little Goose Dam in 2014.

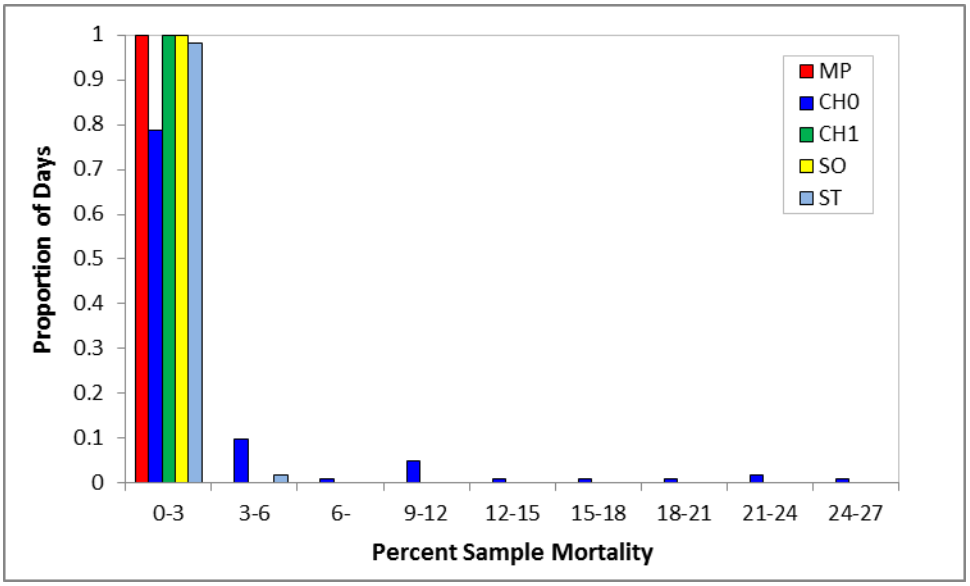

Figure 8. Frequency histogram of sample mortalities for Pacific macropthalmia (MP), subyearling Chinook (CH0), yearling Chinook (CH1), and steelhead (ST) at Lower Monumental Dam in 2014.

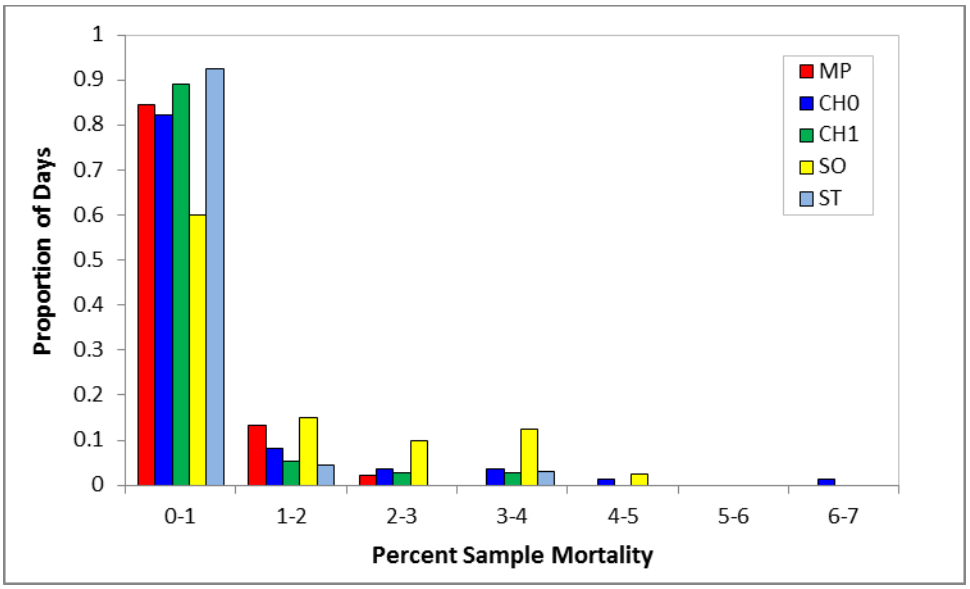

Figure 9. Frequency histogram of sample mortalities for Pacific macropthalmia (MP), subyearling Chinook (CH0), yearling Chinook (CH1), sockeye (SO), and steelhead (ST) at John Day Dam in 2014.

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) in 2012, as these were the only sites with high enough sample counts to warrant condition monitoring. This expanded lamprey condition monitoring has continued since 2012. All sites conducting lamprey condition monitoring in 2014 were provided copies of the Lamprey Condition Monitoring Protocol, which is available on the FPC website: ftp://ftp.fpc.org/FPC32.net/Manuals/ConditionSamplingProtocol_2014a.pdf.

Lamprey Condition Results

Sample Numbers

In 2014, JDA handled a total of 86 Pacific ammocoetes and 4,153 Pacific macropthalmia. Of these, all of the ammocoetes and a subsample of 3,526 (84.9%) macropthalmia were examined for condition. At BON, a total of five Pacific ammocoetes and 1,733 Pacific

macropthalmia were handled in 2014. Of these, all ammocoetes and a subsample of 1,475 (85.1%) macropthalmia were examined for condition. Finally, a total of one ammocoete and 1,002 macropthalmia were handled at MCN in 2014. Of these, all ammocoetes and a subsample of 514 (51.3%) macropthalmia were examined for condition.

Length and Weight

Average lengths and weights of Pacific ammocoetes and macropthalmia from condition monitoring at BON, JDA, and MCN are presented below (Table 5).

Table 5. Average length (mm TL) and weight (g) of Pacific ammocoetes and Pacific macropthalmia sampled for condition monitoring at BON, JDA, and MCN in 2011–2014. Numbers in parentheses are 95% confidence intervals.

Site	Migration Year	Ammocoetes		Macropthalmia	
		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)
	2013	103.9 (78.2-129.5)	3.0 (1.3-4.7)	137.1 (135.7-138.5)	3.6 (3.5-3.7)
	2014	135.4 (120.9-149.9)	3.0 (0.6-5.4)	146.2 (145.6-146.8)	4.4 (4.3-4.4)
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)
	2013	149.2 (142.9-155.5)	5.5 (4.8-6.2)	144.0 (143.7-144.3)	4.1 (4.1-4.2)
	2014	146.8 (144.7-148.9)	5.3 (5.0-5.5)	145.1 (144.8-145.5)	4.2 (4.2-4.3)
MCN	2012	N/A	N/A	142.0 (141.4-142.7)	3.9 (3.9-4.0)
	2013	N/A	N/A	142.1 (141.3-142.9)	4.2 (4.1-4.2)
	2014	N/A	N/A	145.4 (144.4-146.3)	4.3 (4.2-4.4)

Injuries and Predation

In 2014, lamprey condition monitoring continued using the protocol that "injuries" were to be recorded only for instances that could not be clearly attributed to disease, parasites, and/or predators. Therefore, marks that were thought to be consistent with bird marks were recorded as Predator Bird, instead of body injury. (In order to provide additional insight on this issue, FPC staff asked the SMP personnel in 2014 to document body injuries versus injuries that could be attributable to predators. The FPC will continue to work with the USFWS staff to further develop the protocol on distinguishing between true injuries that are caused by the bypass system at the projects and those that may be attributable to predators for future years.)

In 2014, the only injuries that were recorded for Pacific ammocoetes at JDA were body injuries (Table 6). In all, 2.3% of the Pacific ammocoetes examined for condition at JDA had body injuries. Although the numbers examined were low, no injuries were recorded for Pacific ammocoetes at BON in 2014 (Table 6). For Pacific macropthalmia, the most common injuries in 2014 were those attributable to avian predators (Pred-Bird) (Table 7). This was true for all three sites where condition monitoring took place. Overall, Pred-Bird injury rates ranged from 4.3% at MCN to 13.3% at JDA in 2014 (Table 7).

Table 6. Summary of Pacific ammocoete injury and predator marks at John Day (JDA) and Bonneville (BON) in 2011–2014. No Pacific ammocoetes were examined for condition at MCN in 2013 and only 1 in 2012 and 2014.

Site	Year	Number Examined	Body Injury	Eye Injury	Head Injury	Fin Injury	Pred-Bird
JDA	2011	851	5.3%	0.0%	0.7%	0.9%	0.0%
	2012*	165	7.9%	0.0%	0.0%	0.6%	0.0%
	2013	21	0.0%	0.0%	0.0%	0.0%	4.8%
	2014	86	2.3%	0.0%	0.0%	0.0%	0.0%
BON	2012	18	5.6%	0.0%	0.0%	0.0%	0.0%
	2013	8	0.0%	0.0%	0.0%	0.0%	0.0%
	2014	5	0.0%	0.0%	0.0%	0.0%	0.0%

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

Table 7. Summary of Pacific macropthalmia injury and predator marks at John Day (JDA), Bonneville (BON), and McNary dams in 2011–2014.

Site	Year	Number Examined	Body Injury	Eye Injury	Head Injury	Fin Injury	Pred-Bird
JDA	2011	4,245	6.1%	0.2%	0.5%	5.8%	0.0%
	2012*	7,136	0.8%	0.1%	0.5%	1.4%	8.3%
	2013	4,226	0.2%	0.1%	0.4%	1.5%	16.9%
	2014	3,526	0.4%	0.1%	0.6%	0.5%	13.3%
BON	2012	2,291	2.9%	0.0%	0.3%	3.4%	3.7%
	2013	318	1.6%	0.3%	0.0%	4.4%	11.6%
	2014	1,475	1.6%	0.1%	0.2%	2.1%	11.8%
MCN	2012	941	2.8%	0.0%	1.1%	1.9%	5.4%
	2013	635	0.9%	0.3%	0.6%	0.0%	3.5%
	2014	514	0.8%	0.0%	0.0%	0.0%	4.3%

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

Table 8. Summary of total lamprey injury and predator marks at John Day (JDA), Bonneville (BON), and McNary dams in 2011–2014.

Site	Year	Number Examined	Body Injury	Eye Injury	Head Injury	Fin Injury	Pred-Bird
JDA	2011	5,096	5.9%	0.2%	0.6%	5.0%	0.0%
	2012*	7,301	1.0%	0.1%	0.5%	1.4%	8.1%
	2013	4,247	0.2%	0.1%	0.4%	1.5%	16.9%
	2014	3,612	0.4%	0.1%	0.6%	0.5%	13.0%
BON	2012	2,309	2.9%	0.0%	0.3%	3.4%	3.6%
	2013	326	1.5%	0.3%	0.0%	4.3%	11.3%
	2014	1,480	1.6%	0.1%	0.2%	2.1%	11.8%
MCN	2012	942	2.9%	0.0%	1.2%	1.9%	5.4%
	2013	635	0.9%	0.3%	0.6%	0.0%	3.5%
	2014	515	0.8%	0.0%	0.0%	0.0%	4.3%

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

Hemorrhaging

At JDA, no signs of hemorrhaging were noted for Pacific ammocoetes in 2014, but fin hemorrhaging was noted for Pacific macropthalmia (Table 10). At BON, signs of fin hemorrhaging were noted for Pacific ammocoetes while both eye and fin hemorrhaging were noted for macropthalmia (Tables 9 and 10). No signs of hemorrhaging were noted at MCN in 2014 (Table 10). Finally, levels of fin hemorrhaging among Pacific macropthalmia at BON have been substantially and consistently higher than at JDA and MCN (Table 10).

Table 9. Summary of Pacific ammocoete hemorrhaging at John Day (JDA) and Bonneville (BON) in 2011–2014. No Pacific ammocoetes were examined for condition at MCN in 2013 and only 1 in 2012 and 2014.

Site	Year	Number Examined	Eye Hemm.	Fin Hemm.
JDA	2011	851	0.1%	1.3%
	2012	165	0.0%	0.6%
	2013	21	0.0%	4.8%
	2014	86	0.0%	0.0%
BON	2012	18	0.0%	11.1%
	2013	8	0.0%	0.0%
	2014	5	0.0%	20.0%

Table 10. Summary of Pacific macropthalmia hemorrhaging at John Day (JDA), Bonneville (BON), and McNary dams in 2011–2014.

Site	Year	Number Examined	Eye Hemm	Fin Hemm.
JDA	2011	4,245	0.0%	1.1%
	2012	7,136	0.1%	1.1%
	2013	4,226	0.0%	0.9%
	2014	3,526	0.0%	0.3%
BON	2012	2,291	0.2%	6.8%
	2013	318	0.3%	6.0%
	2014	1,475	0.1%	7.1%
MCN	2012	941	0.0%	1.9%
	2013	635	0.2%	0.6%
	2014	514	0.0%	0.0%

Table 11. Summary of total lamprey hemorrhaging at John Day (JDA) and Bonneville (BON) in 2011–2014.

Site	Year	Number Examined	Eye Hemm.	Fin Hemm.
JDA	2011	5,096	0.1%	1.2%
	2012	7,301	0.1%	1.1%
	2013	4,247	0.0%	0.9%
	2014	3,612	0.0%	0.3%
BON	2012	2,309	0.2%	6.8%
	2013	326	0.3%	5.8%
	2014	1,480	0.1%	7.1%
MCN	2012	942	0.0%	1.9%
	2013	635	0.2%	0.6%
	2014	515	0.0%	0.0%

Diseases

For all four years, observations of external disease were observed only on Pacific macropthalmia but were very rare (Tables 12–14). Fungus has been the most common disease observed on Pacific macropthalmia. For 2014, fungus was observed in 0.5% of the macropthalmia at JDA, 0.1% at BON, and 0.0% at MCN (Table 13). Deformities were also observed in Pacific macropthalmia in 2014, at both JDA and BON.

Table 12. Summary of Pacific ammocoete disease at John Day (JDA) and Bonneville (BON) dams in 2011–2014. No Pacific ammocoetes were examined for condition at MCN in 2013 and only 1 in 2012 and 2014.

Site	Year	Number Examined	Columnaris	Fungus	Deformity
JDA	2011	851	0.0%	0.0%	0.0%
	2012	165	0.0%	0.0%	0.0%
	2013	21	0.0%	0.0%	0.0%
	2014	86	0.0%	0.0%	0.0%
BON	2012	18	0.0%	0.0%	0.0%
	2013	8	0.0%	0.0%	0.0%
	2014	5	0.0%	0.0%	0.0%

Table 13. Summary of Pacific macropthalmia disease at John Day (JDA), Bonneville (BON), and McNary dams in 2011–2014.

Site	Year	Number Examined	Columnaris	Fungus	Deformity
JDA	2011	4,245	0.0%	0.2%	0.0%
	2012	7,136	0.0%	1.2%	0.1%
	2013	4,226	0.0%	0.4%	0.1%
	2014	3,526	0.0%	0.5%	0.1%
BON	2012	2,291	0.0%	0.2%	0.0%
	2013	318	0.0%	0.0%	0.0%
	2014	1,475	0.0%	0.1%	0.1%
MCN	2012	941	0.0%	0.1%	0.0%
	2013	635	0.0%	0.8%	0.0%
	2014	514	0.0%	0.0%	0.0%

Table 14. Summary of total lamprey disease at John Day (JDA), Bonneville (BON), and McNary dams in 2011-2014.

Site	Year	Number Examined	Columnaris	Fungus	Deformity
JDA	2011	5,096	0.0%	0.2%	0.0%
	2012	7,301	0.0%	1.2%	0.1%
	2013	4,247	0.0%	0.4%	0.1%
	2014	3,612	0.0%	0.4%	0.1%
BON	2012	2,309	0.0%	0.2%	0.0%
	2013	326	0.0%	0.0%	0.0%
	2014	1,480	0.0%	0.1%	0.1%
MCN	2012	942	0.0%	0.1%	0.0%
	2013	635	0.0%	0.8%	0.0%
	2014	515	0.0%	0.0%	0.0%

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