

Response to comments of draft report “EVALUATION OF PINNIPED PREDATION ON ADULT SALMONIDS AND OTHER FISH IN THE BONNEVILLE DAM TAILRACE, 2017.”

Responses to Dr. Shubha Pandit

Note: Due to the number of revisions and suggested comments received, the line numbers denoted below refer to the newest version of the document, not the original document you commented on. As such, there may be slight discrepancies between line numbers of the original comments and the new version of the manuscript.

Comment #1:

In your methodology, the simple random sampling technique has not been mentioned, which is different than last year’s report. If any results are based on this technique, then you need to include a discussion of methodology for this technique, including how you calculated the Confidence Intervals of any estimated values from this technique. If this technique was not used in 2017, it would be good to more thoroughly discuss all of the modifications in the 2017 sampling design versus previous years.

Thank you for making this important point. Indeed, we did not use a simple random sampling design at all this year. We added text to line 538 to make this distinction clear.

It now reads “This season we elected to consistently apply a systematic sampling design with even coverage within each strata week, a design that is different from last season which involved a combination of simple and stratified random sampling within weeks. We describe the methods and assumptions of these designs below.”

Comment #2:

- Most of the results for salmonid consumption that you presented in this report were adjusted estimates. For example, Tables 4 and 7 show Adjusted Salmon Consumption estimates. Additionally, pinniped predation on salmonids and the associated Confidence Intervals are presented (see page 19 line 744), but it appears that the associated CI was calculated without bootstrapping. It would be good to explain your methods for calculating adjusted estimates and associated CI. You can provide a brief description of the methodology of calculating adjusted salmon consumption estimates and its CI without bootstrapping or refer to last year’s report.

The adjusted estimate is the boot strapped estimate throughout the report. As described in the paragraph starting in line 515, the adjusted estimates are the number of fish

recorded as consumed with the proportional addition of unidentified fish during the same time period.

These adjustments are made using raw data prior to calculating the estimated mean number of fish consumed.

To make this more clear we added the verbiage on line 572 (i.e. “adjusted), and 581 (i.e. bootstrap) to ensure readers understand that all predation estimates except where explicitly noted (e.g. Lamprey) are bootstrap calculated adjusted mean estimates of fish predation.

Comment #3:

- The bootstrapping resampling method is discussed in considerable detail compared to other analyses that you used in the report. I suggest to change a paragraph (the Lines 559-565 of Page 11) to the following:

“.....We estimated the total catch of every resampled table (999 estimates) and calculated the confidence intervals for the true mean (μ) using the distribution of delta [$\delta^* = \bar{x}^* - \bar{x}$]. \bar{x}^* is the mean of the bootstrap sample and \bar{x} is the sample mean. The bootstrap 95% confidence intervals for μ is as: [$\bar{x} - \delta_{0.025}^*$, $\bar{x} - \delta_{0.975}^*$]. “

The detailed description is due to the recent addition of the technique this year and to (hopefully) explain to all audiences the basics of the technique. Your suggested text was used to replace the existing text.

Comment #4:

- You discussed increasing temporal distribution and abundance with reference to the results in Appendix Table 1 (Page 14 Lines 672-673). However it is not clear how these results support this statement. Some additional explanation would be helpful.

The wording has been restructured to properly describe the data.

It now reads:

“Inspection of the data reveal an increasing temporal distribution and abundance of SSLs at BON since 2008, wherein the median number of days present has increased, and the

number of days without SSLs has decreased to almost zero (Supplementary Table 1, Figure 3).”

Comment #5:

- Figure 3 shows very interesting results with variability in the daily population sizes shifting between CSL (California Sea Lion) and SSL (Steller Sea Lion) over 15 years. CSL population was high from 2002 through 2008 but SSL’s population becomes higher after 2009. Would this indicate that these two species compete with each other, or are there other mechanisms behind this pattern? Further consideration and discussion might be good. This could also become a recommendation for further research to determine mechanisms if it is not already evident, similar to your recommendation for more research on dietary shifting of SSL (page 31, lines 973-982).

You make excellent points. The proximate cause underlying the switch is likely the removal of CSLs which started in 2008. The early years of the removals euthanized the most habitual recurring animals at the dam, the animals which if not removed would contribute to the daily abundance counts. However, the ultimate causation for the switch may be a more complex issue that entails a mixture of learned behavior, recruitment, and the removals.

The discussion develops and discusses this finding starting on line 916. For the interests and targets of this report we find the current treatment of this finding to be sufficient, but intend to further explore the relationship in future research.

Comment #6:

- Page 4 lines: 333-334: in your method, to facilitate comparison of predation events you divided the tailrace and Spillway areas into seven zones for your observation. Were any criteria used to stratify these zones? If so, some additional explanation would be helpful.

This is a convention previously employed. The confusion and I believe your issue with the description likely stemmed from the word choice implemented. To clarify this issue we have altered the wording to the following:

“To facilitate comparison of predation events by tailrace area, and provide continuity to previous reports (Madson et al. 2017), we divided each tailrace sub-area into seven zones (Figure 1).”

Minor Comments

- Page 14, line 655. Please provide the figure which supports your statement. Can you assign the figure number like fig 2.a, fig 2.b etc. instead of just Fig 2?
- Page 14: lines 661. similar to above, please provide the figure number at the end of sentence of "...in March and April."

Each plot was labeled with "A" and "B" to make this more clear.

- Page 2 lines 269-270, a reference is needed to support the statement "spring Chinook migration is historically synchronized...."

This comment lead us to revisit this statement which was in fact misleading. The fish are not influenced by the sea lions, rather, the sea lions are following the fish. The entire paragraph was revised to the following:

"Other threatened or endangered salmonid species exposed to pinniped predation near BON include spring Chinook, Chum Salmon (*Oncorhynchus keta*), and Coho Salmon (*Oncorhynchus kistutch*). Pinniped presence in the Columbia River is seemingly synchronized with the Spring Chinook run during the pinniped pre-breeding season, while the post-breeding season appears to be synchronized with the Coho and Chum Salmon migration period. Depredation of any of these ESA-listed stocks could damage run viability and make recovery efforts difficult."

Responses to Ralph Lampman:

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Thank you Kyle for your time in answering my questions. I am still not convinced that the gradual changes in study methods and assumptions over time have not affected the recent decrease in observation and estimates for Pacific Lamprey predation. I see a tremendous value in re-evaluating the study design for May, not just for lamprey but for the overall pinnipeds/salmon dynamics. They are a key player for pinnipeds and potentially for salmon and we need to investigate these assumptions a little further before we try to put a closure and lock them away (as if we already understand them).

Responses to RL comments in (Red) are appended below each comment in Purple.

Comment #1:

Line 430.

The historical FSP was better defined and justified as to why the early portion of the FSP is sampled.

Thanks (saw the added text).

Comment #2:

Due to the changes of the sampling scheme since 2016, we lack the specificity of data to present identical plots to those presented in 2005. As such, we elect to not place incongruent plots in this report that may mislead readers.

However, if the type of information in the requested plot is of interest we may have capacity to provide similar, but not comparable data.

We did however, add a written description of the distribution and chronology of lamprey predation events on Line 802.

To avoid incongruent plots, you could simply show the data for the current year (no need to show the past data – those were already reported). Just showing the temporal pattern (that predation only starts in May and goes up and it happens primarily in the early morning and late night during the day shows an important trend for readers to understand that the current draft doesn't show at all). Appreciate the added description, but if we can simply see the data, it's worth a thousand words (a lot more meaningful).

We added text to the Lamprey section to address these issues and inserted two figures in Supplementary Figure 1.

Comment #3: **The requested plots can be produced. However, given the small number of lamprey predation events compared to the larger number of salmonid events, we fear the relative percentages of salmonid focused consumption would swamp that of the lamprey and make them undetectable in graphic form. Thus, we elect to not insert these plots.**

Maybe true for the earlier months, but for May (especially if you break it into 2 weeks period, even more). That alone is worth noting. With the way it is narrated right now, the readers get the impression that lamprey predation is next to none and pinnipeds are not interested in them. But that's an incomplete picture to paint, as you know, because lamprey only show up later in the season. Everything is temporal. We just need to capture that better. The conclusion drawn about late salmon doing much better may be related to the presence of lamprey (I think it is an important thing to pursue and investigate more).

Comment #4:

Line 531 contains new text to indicate the estimates of lamprey as minimum estimates and captures the points made about nighttime foraging.

We do not agree with the supposition that SSLs are primarily nocturnal foragers. Since 2005 our methods have been refined and we now document the foraging patterns and haul-out patterns of the animals with cameras 24 hours/day. Previous nighttime predation sampling found, and our photo archived camera traps confirm, that there is a strong pattern of diel foraging. As such, we make reference to potential missed predation events during the no light or low light hours and note that some nighttime predation may occur (Line 532), but reject going further with the case, given our current findings and knowledge of the system and animals.

I understand night time predation has been studied at BON. It is likely true that they don't have much to feed in January – April during the night time and hence very little feeding occurs during those months. But I think that will likely change given what's available in May, when lamprey shows up, and I suspect they will change their feeding behavior (being an opportunistic feeder), and that's why I'm suggesting it may be worth taking another look at this timing specific to May. I'm not suggesting that we do this throughout the whole season, that would be a big waste of time and money. But there is enough reason to believe that predation of lamprey goes up (as soon as they start showing up of course) and feeding behavior could very well change as a result.

Below are mainstream websites that suggest SSL being a heavily night time forager. Again, there is a time and place for everything, I understand, so may very well be different at BON (during January – April), but I'm just not convinced that the patterns stay the same in May. More needs to be investigated (during that particular time).

<https://www.fisheries.noaa.gov/species/steller-sea-lion>

Behavior and Diet

Steller sea lions are opportunistic predators, foraging and feeding primarily at night on a wide variety of fishes (including capelin, cod, herring, Atka mackerel, pollock, rockfish, salmon, and sand lance) and cephalopods (including squid and octopus). Their diet varies depending on the abundance and distribution of prey.

<http://www.seaotter-sealion.org/stellersealion/factsssl.html>

Food habits: Steller sea lions are opportunistic and eat a wide range of fish including herring, pollock, salmon, cod and rockfishes, sculpin, Atka mackerel, capelin, as well as squid, shrimp and other fish. To survive, an adult sea lion needs to eat at 5-6% of its body weight each day, but young animals need twice that amount. When males are defending their territories on the rookeries, they may go without eating for over a month!

Interestingly enough, Steller sea lions do not need to drink water because the food they eat

provides them with all the water they need. Sea lions do not chew their food, most is swallowed whole. Feeding often occurs in groups and they often feed at night between 9 PM and 6 AM.

As mentioned previously and stated in the report, our camera traps on haul-out areas support our assertion that the pinnipeds foraging at BON are different from their non-BON conspecifics insofar that they haul-out and are recorded staying hauled out throughout the no-light periods of darkness. These data when combined with the nighttime predation monitoring surveys conducted previously, suggest that very little foraging occurs at night.

In reference to the number of lamprey estimated as consumed and the number of individuals found in one CSL.

The total number estimated is reflects how many were observed consumed this year. The 26 that were found in the stomach of the euthanized sea lion is also true. The discrepancy and potential for questioning, as you highlight, likely stem from a combination of sources: first, the evacuation rate of the stomach of individual CSLs. 26 individual remains were found in a stomach. These remains can stay in the stomach of a CSL for several days before being expulsed. Second, we have previously documented and observed again this season, that some CSLs are lamprey specialists while others do not seemingly forage for them. Thus, the disproportionate impact a few specialists could have could be extrapolated to the entire population of BON CSLs and therein depict a much larger number of predation events, but this would be misleading. A few CSLs consistently forage for lamprey. CSLs averaged 5.1 days at BON this year. Given the few specialists we observed this year the estimates provided in the report are within range of lamprey we might expect to be taken.

Given this, we reject the suggestion to alter the current writing.

Lamprey don't have any bones and their meat deteriorates very fast (especially in warmer May) compared to other fish species. Within several hours, it is hard to identify larval lamprey in a stomach (disintegrates into a black mush quickly), so the fact that you could identify them is an indication that it is fairly fresh (but sure, it may still be 1-3 days old).

When you say some CSL are lamprey specialists, how are you making that call? Do you have ways to identify them individually? Maybe those that you call specialists are special ones that tend to eat lamprey near the surface rather than underwater (hence you see them more often)? I'm not convinced completely that this is not related to a significant under reporting of the lamprey predation.

The quoted reference to Pacific Lamprey consumption by CSLs is the report by ODFW and WDFW on their dietary analysis of removed CSLs. We are confident of our abilities to identify animals through the alpha-numeric brands on the dorsal surface. We observe some

animals consuming Lamprey while others have never been noted doing so. Moreover, of the hundreds of GI tracts the States have necropsied, some CSLs have been found to account for the bulk of the lamprey found in all samples.

Recommendations for future study:

Comment #5:

We appreciate the suggestions for future research and invite suggestions for improvements to the monitoring program to better assess the impacts these animals may be having on lamprey.

In response to these suggestions we offer the following:

SSLs are not primarily nocturnal at BON. See the “natural history” section of the current report.

Pacific Lamprey are easily distinguishable from other fishes when being consumed given their distinct body shape and writhing actions when being consumed. Sub-surface predation is hypothesized for other fish given the number of times observers document almost entirely swallowed animals being brought to the surface, which suggests that some are likely consumed sub-surface. This is not the case for Pacific lamprey. They are brought to the surface whole and swallowed. However, it may occur, thus the addition to the main text.

This is from line 385:

Of particular note for monitoring purposes is the prey handling time and capacities of each species; adult SSLs can swallow sizeable spring Chinook almost whole in a matter of seconds, whereas adult CSLs typically stay at the surface and break the fish into smaller pieces. Thus, handling time differs for each species of sea lion, a difference which likely influences the ability and confidence of observers to document predation and therein may influence inter- and intra-species differences enumerated in this report – SSL predation may be biased low as a result.

In here, you identify the likely underestimation for SSL due to their ability to swallow even spring Chinook in a matter of seconds. Why would they need to bring Pacific Lamprey to the surface, if they can swallow a spring CH in seconds? I guess I don't understand the logics here. The reason you are not seeing almost entirely consumed Pacific Lamprey brought to the surface is not because they don't consume them subsurface, but rather because they don't have a need to bring them to the surface half consumed (they either swallow it, or they bring it to the surface and swallow it there, if it's a lively one, for example). There is simply no need to struggle and consume half the lamprey subsurface and bring them to the surface (no biological reason to do so). I don't understand the logics in using that as a narrative to assume that they don't consume them underwater. It doesn't make sense to me. There has to be a better “reason” to assume that they don't consume them underwater. Sturgeon swallow them like spaghetti. They are super easy to swallow whole and no need to chew and digest them (especially underwater).

The body plan of pacific lamprey and the ways with which they are consumed makes them incredibly conspicuous as a prey item. When captured they squirm and writhe about in such a way that sea lions must make several swallowing attempts. Of the tens of thousands of hours spent observing these predation attempts, observers at the FFU have only rarely witnessed a sea lion emerge from the water with a mostly consumed lamprey. As such, we maintain that the sub-surface predation of the species is minimal at best.

Comment 6: The Pacific lamprey passage numbers are so large that the percentage consumed by pinnipeds would be a very small number to report. See the below table for reference to when we have relatively good confidence for our passage estimates.

| Year | Expanded Pacific Lamprey Consumption Estimate | Lamprey passage | Consumed/passage |
|------|---|-----------------|------------------|
| 2002 | 47 | | |
| 2003 | 317 | | |
| 2004 | 816 | | |
| 2005 | 810 | | |
| 2006 | 424 | | |
| 2007 | 143 | | |
| 2008 | 145 | | |
| 2009 | 102 | | |
| 2010 | 77 | | |
| 2011 | 33 | | |
| 2012 | 79 | 93456 | 0.0008 |
| 2013 | 66 | 84347 | 0.0007 |
| 2014 | 85 | 120100 | 0.0007 |
| 2015 | 196 | 130332 | 0.001 |
| 2016 | 501 | 121850 | 0.004 |
| 2017 | 191 | 290468 | 0.0006 |

All year's estimates at BON are "estimates" for Pacific Lamprey. There is no clear difference in the accuracy for the earlier years vs. more recent years (I understand these numbers very well). I don't understand why you omitted the earlier years (and I really think the lower #s in more recent years is a result of more room to underreport and underestimate the lamprey predation due to the changing focus.)

The run of Pacific Lamprey in May at BON is only about 5% of the total run. In 2004, over 1% of the run was confirmed to be preyed on by pinnipeds. >1% of 5% is >20%. That's a considerable rate of predation, I would say, if we examine it by the specific temporal timing that they coincide. We just need to provide that context a little better.

In 2005-2007, 4.6-13.1% of the predation catch were lamprey (& that was considered an underestimate). This is huge considering that only about 5% of the lamprey run coincides with the pinniped presence. I believe more focus is warranted on this species (during May), so we can have a better understanding of the predation dynamics.

We recognize the variable nature of quantifying lamprey passage and selected the above dates as examples to illustrate the point that predation across the entirety of the run is minimal. Your point of synching the predation level to the percent of the run that has passed at that time is well taken. However, for the sake of continuity within this report (i.e. the way impacts to salmon have been reported as percent of entire run) we elect to remove this section from the report and report the numbers that have been previously reported.

Requests to analyze the impacts of pinnipeds specifically on Pacific Lamprey are welcome, and would provide the platform with which to thoroughly explore the above mentioned items not currently addressed in these revisions.

Responses to Doug Hatch:

Note: Due to the number of revisions and suggested comments received, the line numbers denoted below refer to the newest version of the document, not the original document you commented on. As such, there may be slight discrepancies between line numbers of the original comments and the new version of the manuscript.

We agree with and incorporated most of the suggested changes. Major alterations and all additions are enumerated below.

Line 64: Comment: "Breaking out predation by species (CSL and SSL) is important for the 120 evaluation."

We elect to reject this suggestion due to the need for brevity in the summary. We recognize the need to split by species and we feel the report properly splits the by-species impact.

Line 218: Comment: “Upper Columbia generally refers to areas upstream of the Yakima River by some, and upstream of the Methow by others. From Celilo Falls downstream is the Lower Columbia River.”

We removed the term “upper” to make it more general and better describe the region.

Line 272: Suggested addition of lamprey language.

We elect to incorporate the lamprey addition and expanded this section to give more emphasis to the lamprey and the potential impacts thereto.

Line 943: Suggested clarification to the time period.

We included the defined “FSP” period.

Line 1027: Comment: “Animals that are around long enough to be branded would not be considered naïve by most folks. At least in the Task Force. A truly naïve animal is one that moves up the river, is subjected to hazing and then leaves. Who knows if that actually happens, but that is the argument made by some Task Force members supporting continuing hazing.”

We agree with the suggestion and have altered it to better define what animals might be naïve and were used in the analysis. It now reads:

“Albeit arguments concerning naïve animal exposure to, and subsequent dispersal from, the hazed area are valid (Brown et al. 2017), our data calls into question the effectiveness of these treatments. Recently branded CSLs (i.e. newly recruited individuals [potentially naïve] and individuals not previously branded) that were not removed this season spent the same number of days (both observed and the potential number of days present) as those animals branded prior to 2017. Suggesting that some newly recruited individuals, once marked and exposed to hazing, spend the same length of time foraging at BON as habituated animals that have been hazed for the last three years.

Line 1080: Apologies for the omission of your name in the acknowledgements! It has been added.

Responses to Dalin D’Alessandro and Dr. Deb Duffield

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commented on. As such, there may be slight discrepancies between line numbers of the original comments and the new version of the manuscript.

We agree with and incorporated all of the suggested changes save for the following:

Line 48: Comment: do not use “s” at the end of CSL or SSL.

We elect to reject this suggestion. The pluralization of these acronyms is important to the flow and preciseness of the text.

Line 412: Suggested removal of colon.

We elect to reject this suggestion. The following text is a list, as such the colon is warranted and creates the intended effect.

Line 423: Suggested removal of “Field Glasses”

We elect to reject this suggestion. Field glasses are the most accurate description of the materials used.

Line 641: Suggested clarification to the dates animals left and arrived to the dam again.

We agree with the need for clarification and have revised to the following:

“All pinnipeds left BON by May 30, during the 2016 FSP. Soon after the 2016 FSP, sporadic observations of one to two pinnipeds were made between June 22 and August 15, 2016 after which time \geq six SSLs were documented on a daily basis.”