Effectiveness review of Marine Mammal Protection Act Section 120 implementation under 2012 Letter of Authorization to Washington, Oregon, and Idaho

February 8, 2017

Overview

On March 15, 2012, the National Marine Fisheries Service (NMFS) issued a Letter of Authorization (LOA) pursuant to Section 120 of the Marine Mammal Protection Act (MMPA) to the states of Washington, Oregon, and Idaho (States) to lethally remove certain individually identifiable California sea lions (CSLs) at Bonneville Dam that were having a significant negative impact on the decline or recovery of at-risk salmon and steelhead. That LOA expired June 30, 2016, but a request by the states for a renewal was granted on June 28, 2016, resulting in a new 5-year LOA starting July 1, 2016. A complete chronology of these events can be found at the NOAA Fisheries West Coast Region website[1].

As part of the MMPA Section 120 process, subsection (c)(5) states that "*After implementation of an approved application, the Pinniped-Fishery Interaction Task Force [(Task Force)] shall evaluate the effectiveness of the permitted intentional lethal taking or alternative actions implemented. If implementation was ineffective in eliminating the problem interaction, the Task Force shall recommend additional actions. If the implementation was effective, the Task Force shall so advise the Secretary, and the Secretary shall disband the Task Force.*" Since the final year of implementation results were not available at the time of the 2012 LOA expiration and corresponding renewal request, the effectiveness assessment was deferred until that information became available. Now that it is available, the purpose of this document is to provide the Task Force with a summary of the complete results of the 5-year implementation in order to evaluate its effectiveness and recommend what, if any, additional actions should be implemented under the current 2016 LOA. Below we provide a summary of the 5-year program as well as address, where possible, the list of data and information requested by the Task Force during their May 31, 2016 conference call[2].

Summary of Section 120 program as implemented under the 2012 LOA (and prior)

The following text, tables, and figures are excerpted from annual state, tribal, and federal reports on Section 120 and related activities in the Columbia River.

[1] http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/authorized_states.html
[2] http://www.westcoast.fisheries.noaa.gov/publications/protected_species/marine_mammals/pinnipeds/June2016/5.31.2016_bonneville_2016_pfitf_meeting_report_final.pdf

Annual summaries of observation effort and minimum numbers of individual pinnipeds observed at Bonneville Dam.

Table 1. Minimum estimated number of individual pinnipeds observed at Bonneville Dam tailrace areas and the hours of observation from January 1 to May 31, 2002 to 2016.

Year	Total Hours Observed	California Sea Lions	Steller Sea Lions	Harbor Seals	Total Pinnipeds
2002	662	30	0	1	31
2003	1,356	104	3	2	109
2004	516	99	3	2	104
2005*	1,109	81	4	1	86
2006	3,650	72	11	3	86
2007	4,433	71	9	2	82
2008	5,131	82	39	2	123
2009	3,455	54	26	2	82
2010	3,609	89	75	2	166
2011	3,315	54	89	1	144
2012	3,404	39	73	0	112
2013	3,247	56	80	0	136
2014	2,947	71	65	1	137
2015	2,995	195	69†	0	264
2016	1,974	149	54‡	0	203

* Regular observations did not begin until March 18 in 2005.
† In 2015, the minimum estimated number of Steller sea lions was 55. This number was less than the maximum number of Steller sea lions observed on one day, so the maximum number observed on one day was used as the minimum estimated number.
‡ In 2016, the minimum estimated number of Steller sea lions was 41. This number was less than the maximum number of Steller sea lions observed on one day, so the maximum number observed on one day was used as the minimum estimated number.

Source: Draft Evaluation of pinniped predation on adult salmonids and other fish in the Bonneville Dam Tailrace, 2016. U.S. Army Corps of Engineers.

Annual mean and maximum daily pinniped abundance at Bonneville Dam.

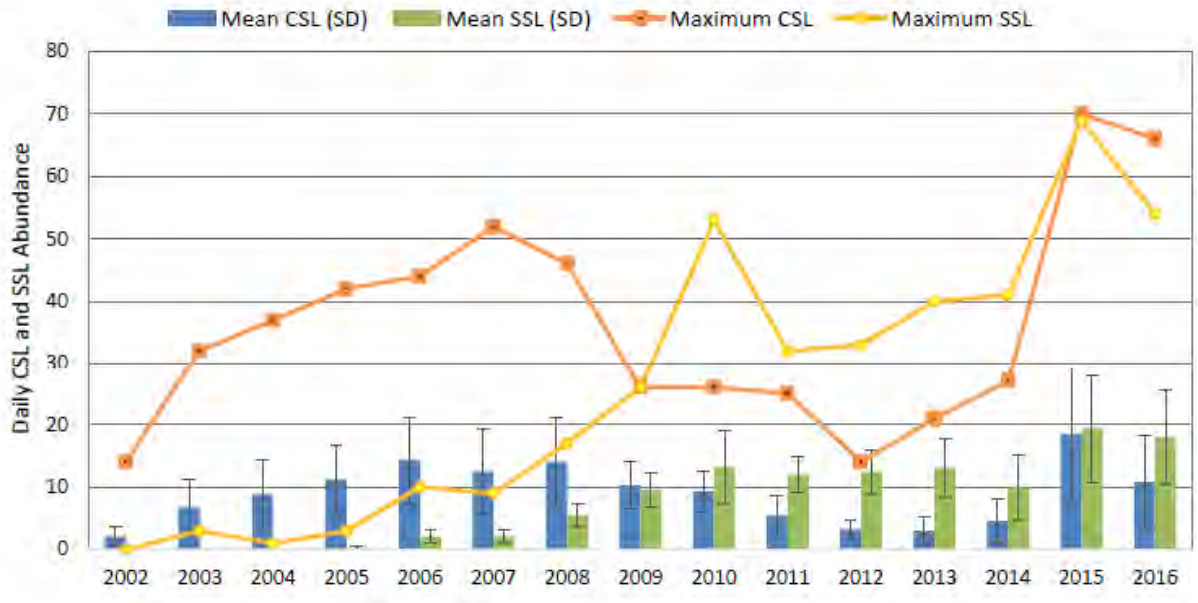


Figure 5. Abundance of California sea lions (CSL) and Steller sea lions (SSL) present at Bonneville Dam from January 1 through May 31, 2002 to 2016. Error bars are ± one standard deviation.

Source: Draft Evaluation of pinniped predation on adult salmonids and other fish in the Bonneville Dam Tailrace, 2016. U.S. Army Corps of Engineers.

Annual mean and maximum observed residency of identifiable CSLs at Bonneville Dam.

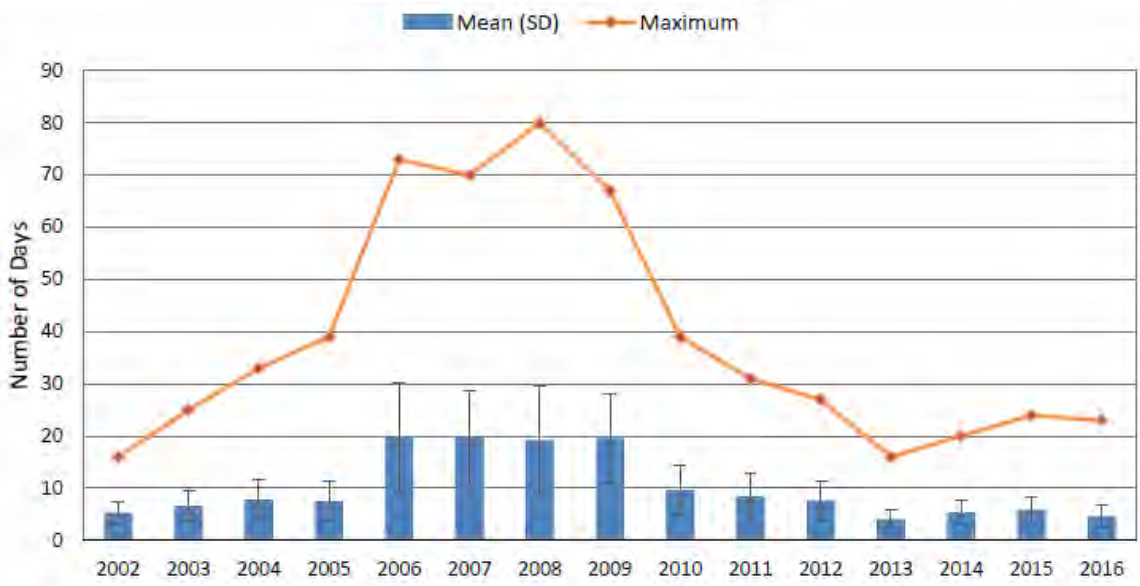


Figure 6. The mean and maximum number of days individually identified California sea lions (CSL) were observed at Bonneville Dam between January 1 and May 31, 2002 to 2016. Error bars are ± one standard deviation.

Source: Draft Evaluation of pinniped predation on adult salmonids and other fish in the Bonneville Dam Tailrace, 2016. U.S. Army Corps of Engineers.

[Note that the above summary is a negatively biased estimate of "residency" at the dam due to the fact that the probability of detecting an identifiable sea lion, given that it is there, is less than one. The Section 120 program has successfully reduced observed residency times since 2008 due to removal of all of the high-residency individuals and prevention of new animals from staying at the dam for long periods of time.]

Annual salmonid predation by sea lions at Bonneville Dam.

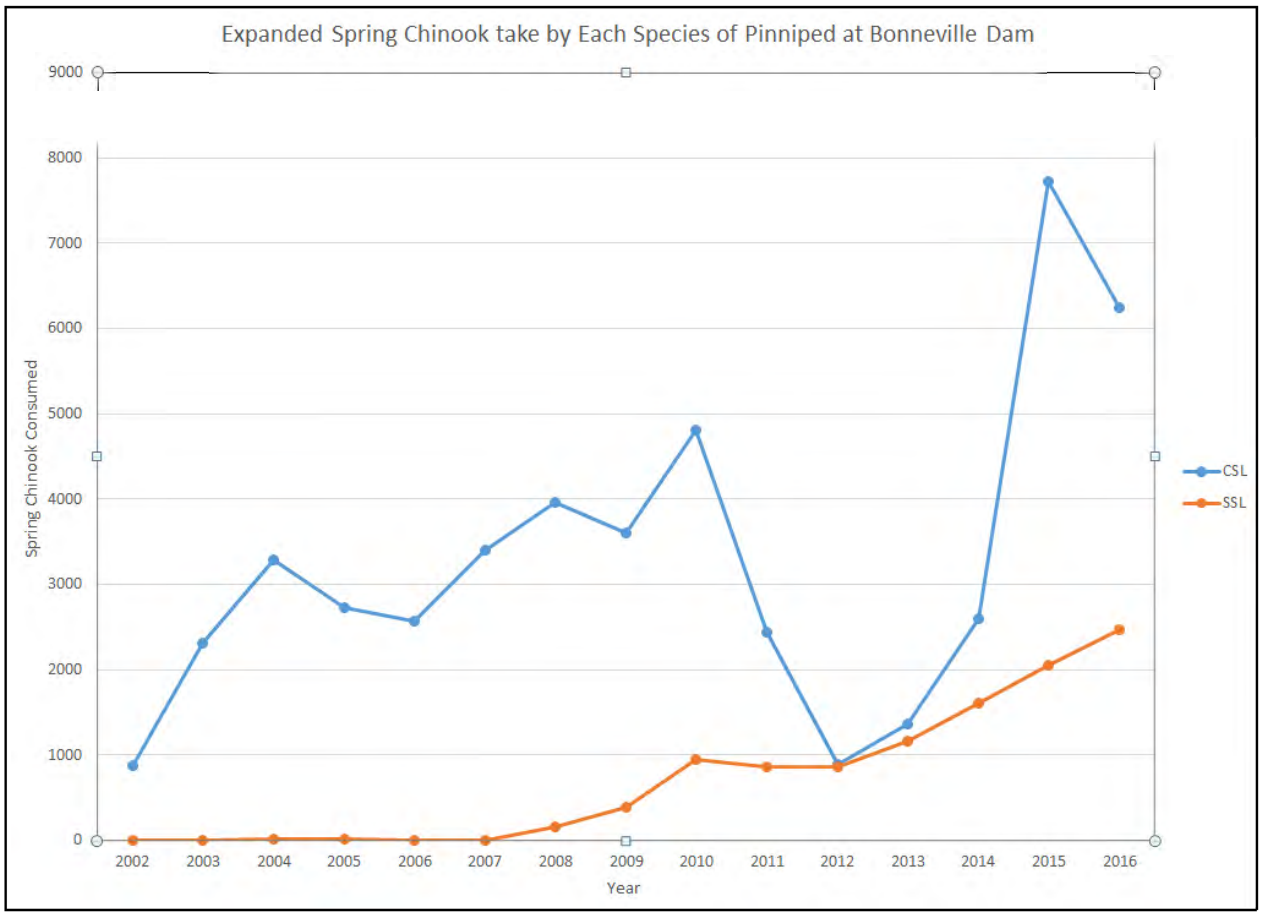
Appendix C. Table of progressive estimates of pinniped predation on salmonids (also broken out by pinniped species) at Bonneville Dam, 2002-2016, adjusted for unidentified fish prey caught.

ADJUSTED FOR DAYLIGHT HOURS AND DAYS NOT OBSERVED

			ALL PINNIPEDS		CALIFORNIA SEA LIONS		STELLER SEA LIONS	
	TOTAL HOURS OBSERVED	TOTAL SALMONID PASSAGE	ESTIMATED SALMONID CATCH	% RUN TAKEN	ESTIMATED SALMONID CATCH	% RUN TAKEN	ESTIMATED SALMONID CATCH	% RUN TAKEN
2002	662	284,732	1,010	0.35%	1,010	0.35%	0	0.00%
2003	1,356	217,934	2,329	1.06%	2,329	1.06%	0	0.00%
2004	516	186,771	3,533	1.86%	3,516	1.85%	7	0.00%
2005	1,109	81,252	2,920	3.47%	2,904	3.45%	16	0.02%
2006	3,650	105,063	3,023	2.80%	2,944	2.72%	76	0.07%
2007	4,433	88,474	3,859	4.18%	3,846	4.17%	13	0.01%
2008	5,131	147,558	4,466	2.94%	4,292	2.82%	174	0.11%
2009	3,455	186,056	4,489	2.36%	4,037	2.12%	452	0.24%
2010	3,609	267,167	6,081	2.23%	5,095	1.86%	986	0.36%
2011	3,315	223,380	3,557	1.57%	2,527	1.11%	1,030	0.45%
2012	3,404	171,665	2,107	1.21%	998	0.57%	1,109	0.64%
2013	3,247	120,619	2,714	2.20%	1,402	1.14%	1,312	1.06%
2014	2,947	219,929	4,314	1.92%	2,615	1.17%	1,699	0.76%
2015	2,995	239,326	9,981	4.00%	7,779	3.12%	2,202	0.88%
2016	1,974	154,074	8,969	5.50%	6,371	3.9%	2,598	1.6%

Source: Draft Evaluation of pinniped predation on adult salmonids and other fish in the Bonneville Dam Tailrace, 2016. U.S. Army Corps of Engineers.

Annual Chinook salmon predation by sea lions at Bonneville Dam.



Source: U.S. Army Corps of Engineers.

State/CRITFC hazing activities at Bonneville Dam, 2008-2016.

		Take*		Munitions	
Year	Days	CSL	SSL	Cracker shells	Seal bombs
2008	89	830	523	9,225	3,148
2009	57	612	427	10,227	1,627
2010	44	202	377	4,921	777
2011	38	173	359	7,839	2,439
2012	31	112	371	1,183	401
2013	34	114	359	740	392
2014	35	188	170	710	440
2015	31	474	231	1,254	735
2016	28	358	452	1,006	715

* Take refers to numbers of animal-harassment events (note: one animal may be harassed multiple times).
Source: State/CRITFC field reports

Annual California sea lion removals at Bonneville Dam.

Table 4. Summary of California sea lion removal activity since initiation of MMPA Section 120 removal program. Removals are categorized by location (Bonneville Dam or Astoria), season (spring or fall), and outcome (captivity, chemical euthanasia, accidental mortality). Accidental mortalities are further categorized by whether animals were on the list for removal or had qualified to be on the list.

Year	Bonneville Dam					Astoria		Total
	Captivity	Accident – on list	Accident – qualified	Accident – not qualified	Euthanized	Euthanized (spring)	Euthanized (fall)	
2008	6	2	1	2				11
2009	4				10		1	15
2010					12		2	14
2011						1		1
2012	1				11		1	13
2013	2				2			4
2014					15			15
2015	2			2	30			34
2016					59			59
Total	15	2	1	4	139	1	4	166

Source: Field report: 2016 pinniped research and management activities at Bonneville Dam. Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, and Columbia River Inter-Tribal Fish Commission.

Bioenergetic modeling of the potential effects of California sea lion removals at Bonneville Dam.

The mean daily salmonid biomass requirement for a California sea lion based on the bioenergetics model was 13.4 kg (95% percentile confidence interval was 7.9 to 21.3 kg/day), which translated into a mean of 2.4 Chinook/day (95% percentile confidence interval was 1.4 to 3.7 Chinook/day) and a percent-of-body-mass of 4.2%/day (95% percentile confidence interval was 2.6% to 6.5%). While it is important to note that bioenergetic models produce estimates of food requirements, not food consumption, these results were nonetheless consistent with data from captive California sea lions that showed adult males consumed an average of 10.9 kg/day (and up to a maximum of 35.5 kg/d) on a diet of mackerel, herring, sprat, and squid (Kastelein et al. 2000).

The predicted number of salmonids that hypothetically would have been required for the 166 California sea lions that were removed from 2008-2016 was 24,466 fish (95% percentile confidence interval was 14,329 to 38,795 fish). In addition to preventing the loss of future fish, removal of habituated sea lions is believed to reduce opportunities for new, naive animals to be recruited into the Bonneville Dam "population", since at least some naive animals are thought to follow habituated animals upriver from haul-outs near the mouth of the river.

Source: Field report: 2016 pinniped research and management activities at Bonneville Dam. Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, and Columbia River Inter-Tribal Fish Commission.

Information requested by Task Force during May 31, 2016 conference call

The following bullet-points come from the *Final Report and Recommendations of the Bonneville Pinniped-Fishery Interaction Task Force* dated June 2016 and were identified by the Task Force as information and data they would like to have in order to evaluate the Section 120 program's effectiveness. We address each in turn, including whether or not the request could be met given available staff time and/or availability of the data.

- Data presented in reports across the years and within the same year

We interpreted this point to mean a summary of activities that occurred during each year of the 2012 LOA. This data is presented above as a series of excerpted text, tables, and figures from state, tribal, and federal annual reports.

- Better CSL tracking data and identification data

We interpreted this point as a recommendation going forward to improve our ability to identify individual CSLs. In 2017 the States plan on expanding their program of using automated cameras to identify branded sea lions hauled out on each of the traps and possibly on other haul-outs such as Tower Island. The States and Corps will also begin sharing their photo catalogs in order to better track and identify sea lions present at the dam.

- Data presented in a manner that clearly distinguishes CSL and Steller sea lion impacts, not just lumping together all “pinnipeds”

We interpreted this point as a recommendation that the USACE reports separate Steller sea lions and CSLs in all of their summaries and analysis. We note, however, that while some summaries are presented as "pinnipeds", most summaries are already separated by species (e.g., see Table 1, Figure 5, and Appendix C form the draft 2016 USACE report).

- Status of the CSL population

The last time the stock assessment for CSLs was revised was in 2014[3]. The status of the stock as defined in that report is as follows:

California sea lions in the U.S. are not listed as "endangered" or "threatened" under the Endangered Species Act or as "depleted" under the MMPA. The optimum sustainable population (OSP) status of this population has not been formally determined. The average annual commercial fishery mortality is 331 animals per year (Table 1). Other sources of human-caused mortality (shootings, direct removals, recreational hook and line fisheries, tribal takes, entrainment in power plant intakes, etc.) average 58 animals per year. Total human-caused mortality of this stock is at least 389 animals per year. California sea lions are not considered "strategic" under the MMPA because total human-caused mortality is less than the PBR (9,200). The total fishery mortality and serious injury rate (389 animals/year) for this stock is less than

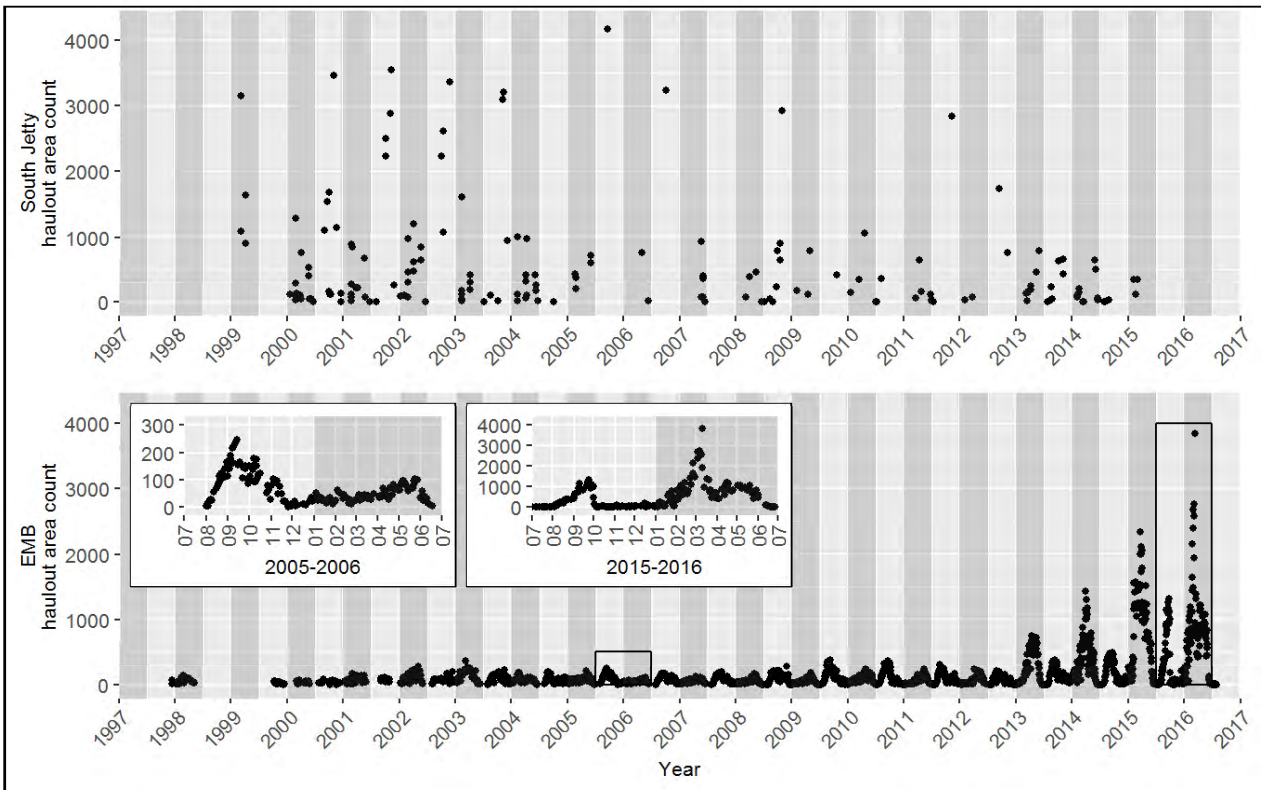
[3] http://www.nmfs.noaa.gov/pr/sars/pdf/pacific_sars_2014_final_noaa_swfsc_tm_549.pdf

10% of the calculated PBR and, therefore, is considered to be insignificant and approaching a zero mortality and serious injury rate.

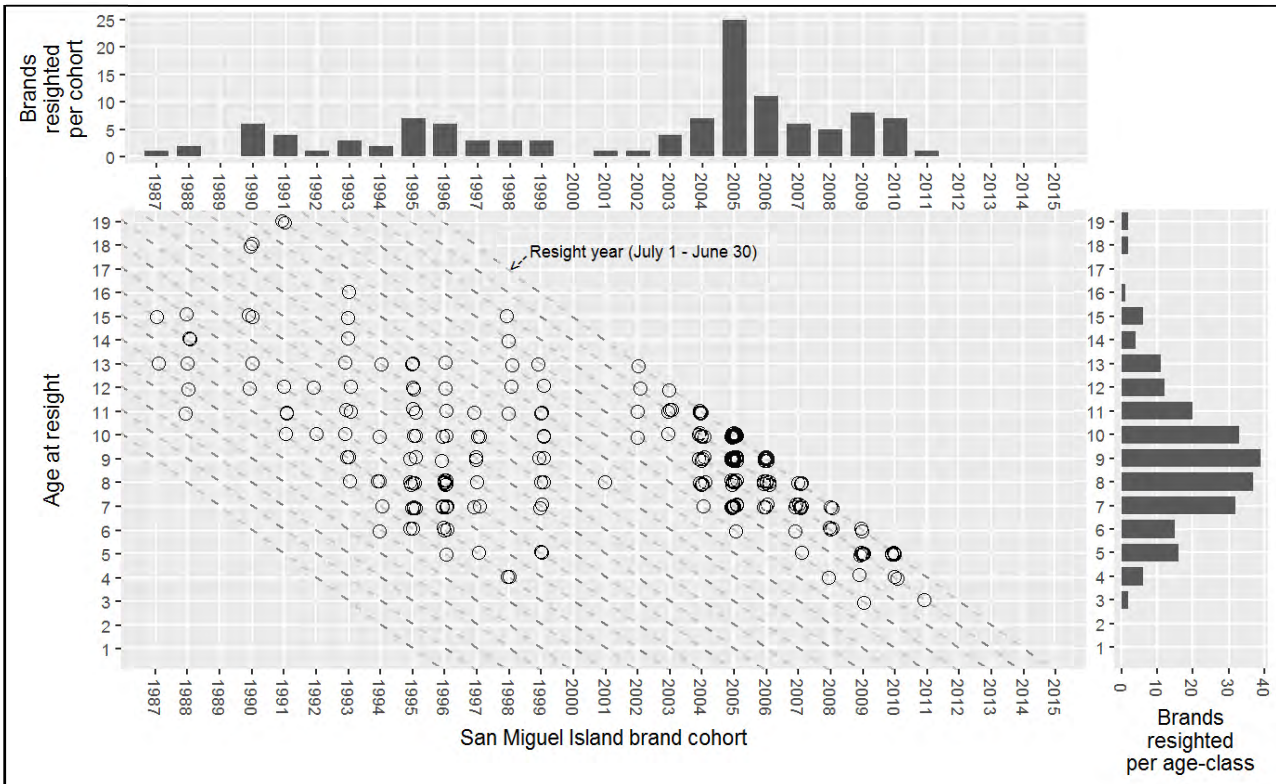
CSLs have experienced a recent population decline which is not reflected in the current SAR. The decline results from decreased numbers of pups born, increased pup mortality and decreased survival to 1 and 2 years of age that have been recorded between 2009 and 2015 (Marine Mammal Laboratory, AFSC, unpublished data) As a result, whereas in 2015 there were approximately 67,000 males ≥4 years of age, by 2020 there is expected to be 10,000-15,000 fewer males ≥4 years of age. PBR, however, is expected to remain at a level that would have no practical effect on removals at Bonneville Dam.

- Data on recruitment levels – numbers and demographics of CSL in the entire Columbia River, not just at the Bonneville Dam

See draft figures below which are from a manuscript authored by state biologists that will soon be submitted for peer-reviewed publication. The first graph addresses the numbers in the lower Columbia River and the second addresses the age distribution (note that nearly all CSLs in the Pacific Northwest are males).



DRAFT (DO NOT CITE) Time series of California sea lion haul-counts at the South Jetty (top) and East Mooring Basin (bottom) haulout areas from December 1997 to June 2016. Insets in bottom plot show seasonal pattern and magnitude of counts at the EMB for select years.

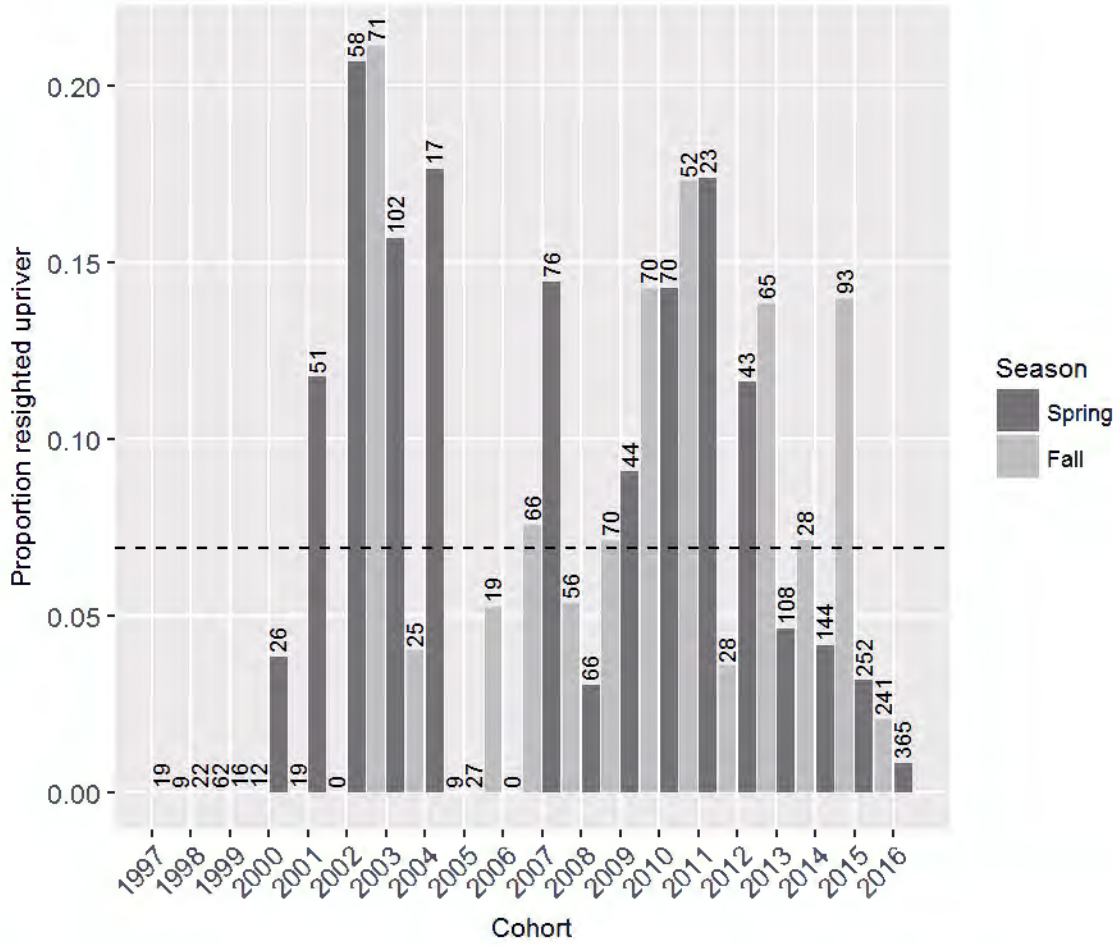


DRAFT (DO NOT CITE). Age distribution of California sea lions branded as pups at San Miguel Island, CA, and later resighted in the Columbia River.

- Trends in general and trends at Bonneville – what proportion of the overall CSL population is counted in river, and what proportion of the population in the lower river is moving up to the dam?

The highest California sea lion count to date at any one time has been approximately 4000 individuals (many more individuals, however, might cumulatively use the Columbia River for some period of time over the course of the year). Using the 2015 population estimate from above, a rough estimate of the proportion of the migrant sub-adult/adult male CSL population in the Pacific Northwest that use the river would be 4K / 67K = 0.06.

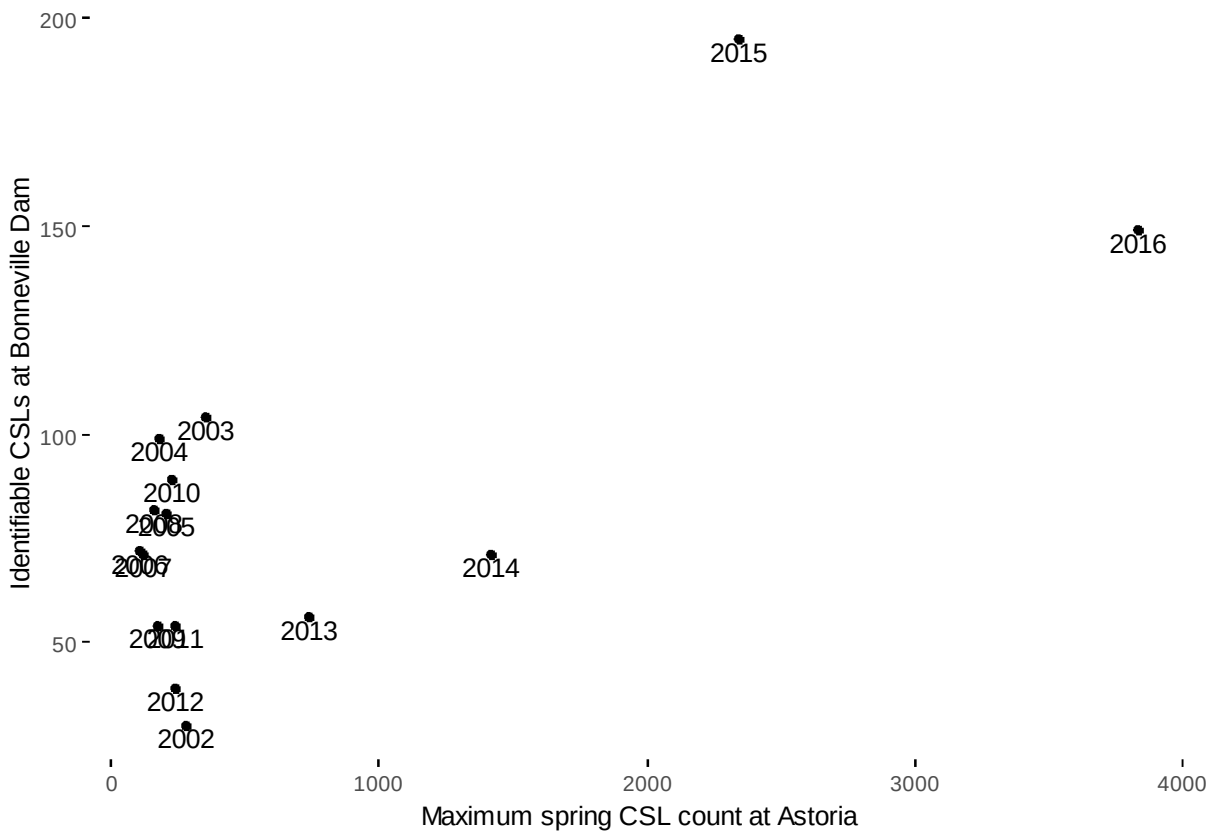
The proportion of the population in the lower river moving up to the dam, based on animals branded in the East Mooring Basin (EMB), varies from year to year but has averaged approximately 7%:



DRAFT (DO NOT CITE) Proportion of spring and fall brand cohorts later observed upriver at Bonneville Dam and/or Willamette Falls. Sample size (i.e., number of brands per cohort) is denoted at the top of each bar; horizontal dashed line indicated proportion of pooled samples (excluding spring 2016) later observed upriver.

- Use the annual high counts in the lower river to compare proportional prevalence there to the counts at Bonneville.

See graph below:



Scatterplot of maximum spring CSL counts in the EMB, Astoria versus total identifiable CSLs at Bonneville Dam from 2002-2016. Bonneville Dam data comes from Table 1 of 2016 USACE draft report.

- Raw numbers of impact (e.g. fish consumed), not just percentages of run consumed

These numbers are presented in Appendix C and elsewhere in the annual USACE reports.

- Run timing of listed salmonid populations and timing of predation – are specific runs at greater risk?

This information can be found in the paper by Keefer et al. (2012)[4], specifically Figure 7 (see below) which shows the migration timing of returning adult salmon:

[4] https://www.researchgate.net/publication/263554134_Use_of_Radiotelemetry_and_Direct_Observations_to_Evaluate_Sea_Lion_Predation_on_Adult_Pacific_Salmonids_at_Bonneville_Dam

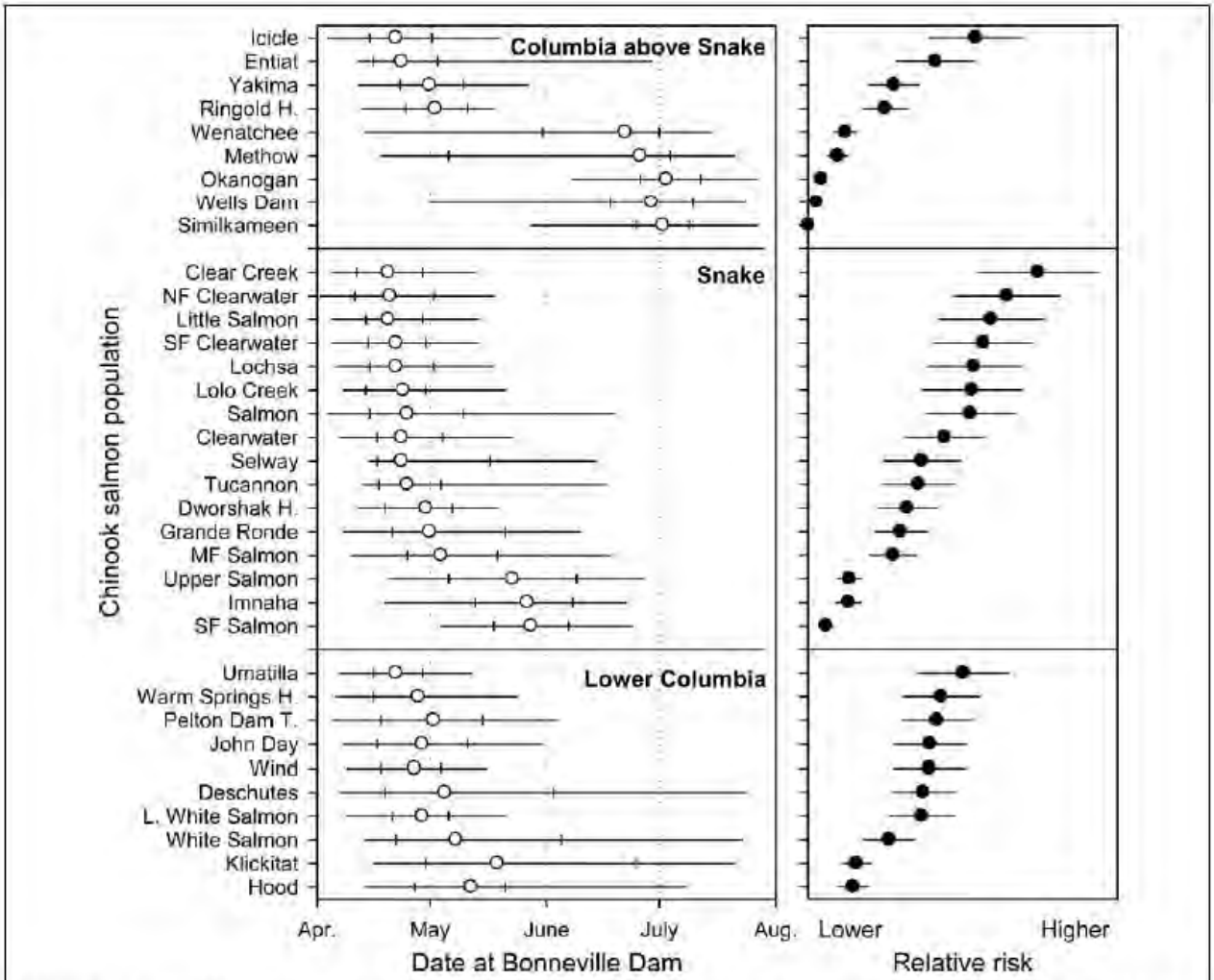


FIGURE 7. Left panel: Migration timing distributions calculated using 5,229 radio-tagged spring and summer Chinook salmon from 32 upriver populations in the lower Columbia River, Snake River, and Columbia River upstream from the Snake River confluence, 1996–1998 and 2000–2004. Distributions show 5th, 25th, 50th, 75th, and 95th percentiles. Right panel: the relative risk (± 1 SE) of predation by pinnipeds, estimated by multiplying weekly mean predation rate estimates from the pinniped observation study (i.e., mean $Catch_{week}$ / $Count_{week}$) by population-specific migration timing distributions. Warm Springs Hatchery and Pelton Dam Trap are in the Deschutes River basin. Ringold Hatchery is adjacent to the Columbia River main stem. Dworshak Hatchery is in the Clearwater River basin.

- Scat testing to get at stock identity

While feasible, we have conducted very little genetic testing of undigested salmonid structures recovered from CSLs at Bonneville Dam.

- PIT tag data from Bonneville

The few PIT tags we have recovered from euthanized CSLs have been from smolts. For example, California sea lion C930 (euthanized in 2014) contained the remains from 49 smolt, including 2 with PIT tags. The two PIT tags were identified as having been from hatchery spring Chinook smolts (125 mm in length) released from Little White Salmon National Fish Hatchery just five days prior to the removal of C930.

- Michelle Rubs' 'river at large' tracking data

The data in question has yet to be published but a summary can be found here: https://www.nwcouncil.org/media/7150415/f4.pdf

- Salmonid genetic and life history impact from CSL

We are unaware of any data or information being available on this topic.

- River-wide predation

This is a subject of active but incomplete and inconclusive research (e.g., see https://www.nwcouncil.org/media/7150415/f4.pdf, http://www.nwcouncil.org/media/7150626/isab2016-1.pdf)

- Accelerometer study results for better understanding predation

This analysis is anticipated to be of great value for increasing the accuracy of predation rates but is currently beyond our capabilities given limited staffing and funding. However, the following figures from the States 2015 annual report[5] provide an example of preliminary study results:

[5] http://www.westcoast.fisheries.noaa.gov/publications/protected_species/marine_mammals/pinnipeds/sea_lion_removals/odfw_2015_mmpa_sec_120_field_report.pdf

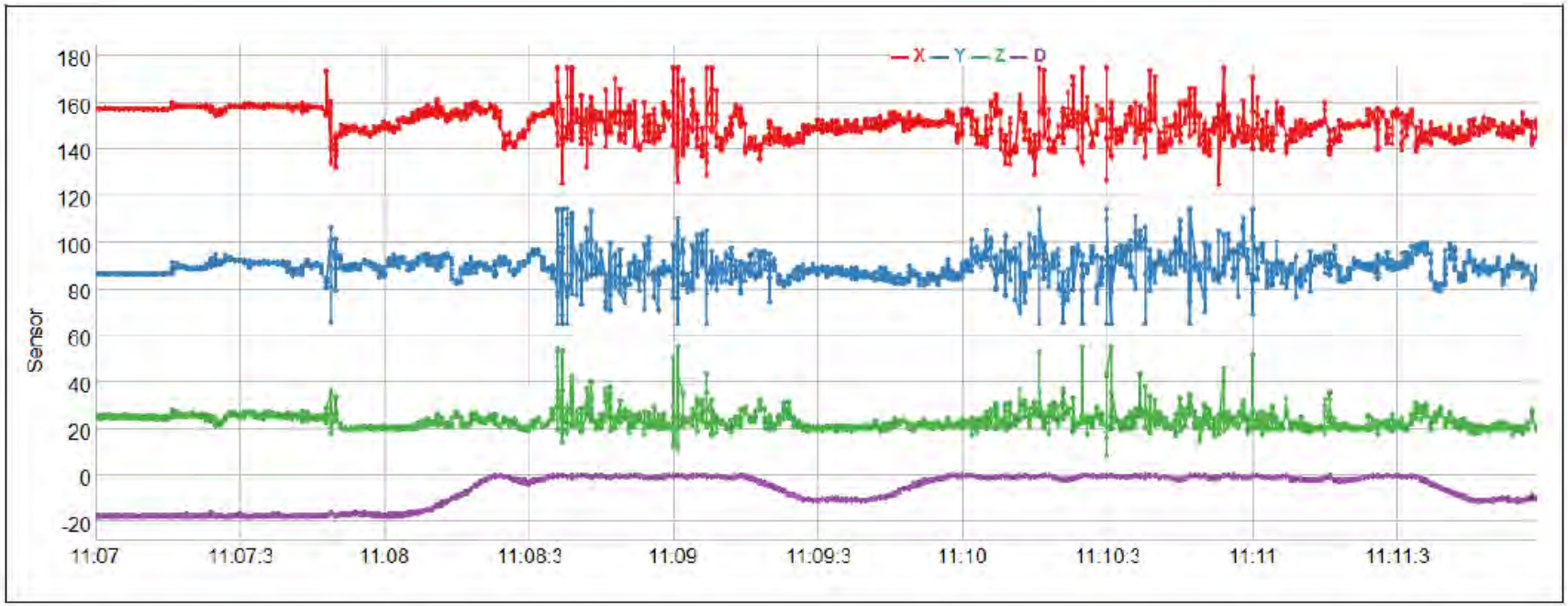


Figure 1. Accelerometer and depth data from a single salmon predation event by California sea lion C040 between 1107 and 1114 on 2015-04-09. Lines represent sensor data: surge (front-back acceleration) is at top in red; sway (left-right acceleration) is second from top in blue; heave (up-down acceleration) is second from bottom in green; and depth is at bottom in purple. Acceleration (surge, sway, and heave) is measured in meters per second per second but are offset above for display purposes; depth is measured in meters.

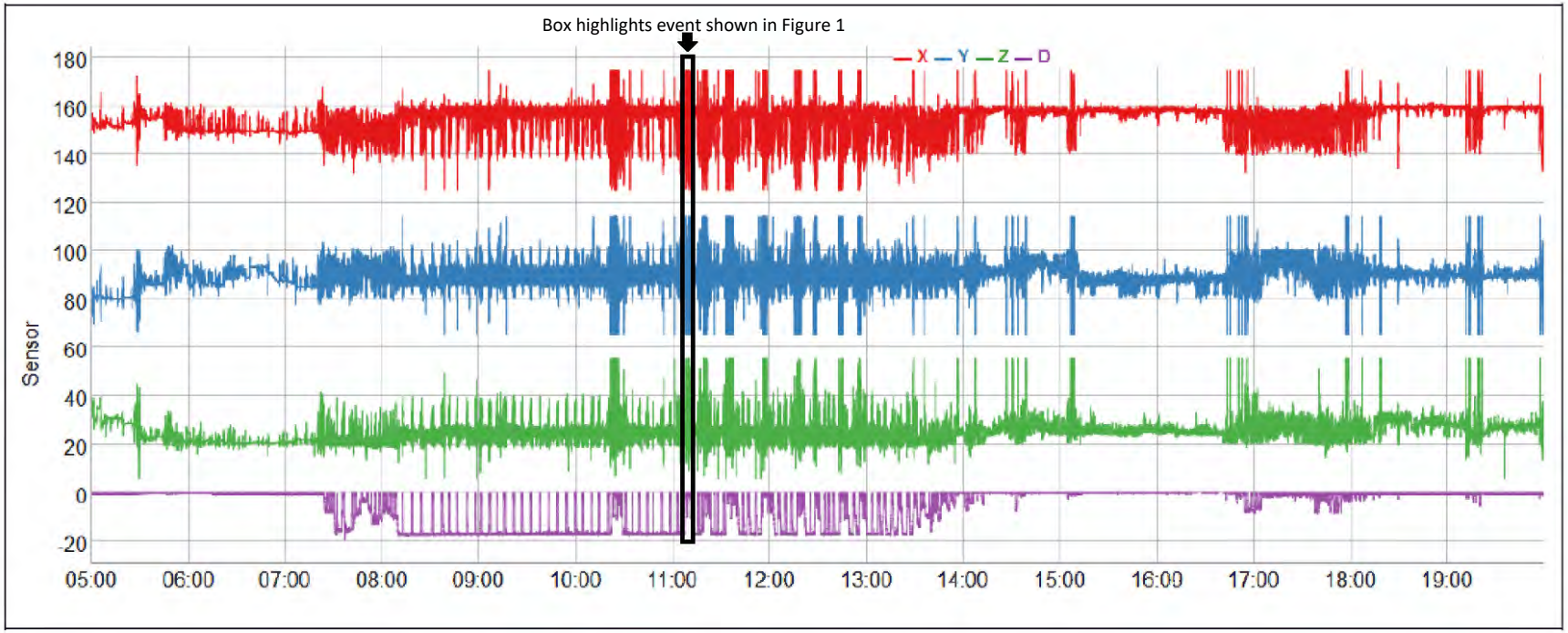


Figure 2. Accelerometer and depth data from California sea lion C040 between 0500 and 2000 on 2015-04-09. Lines represent sensor data: surge (front-back acceleration) is at top in red; sway (left-right acceleration) is second from top in blue; heave (up-down acceleration) is second from bottom in green; and depth is at bottom in purple. Acceleration (surge, sway, and heave) is measured in meters per second per second but are offset above for display purposes; depth is measured in meters.

- Are there highly effective predators at Bonneville that are there for multiple years and are not being trapped and removed?

We're not sure if this question can be answered with available data and resources. In order to categorize a sea lion as being "highly effective" it must be documented catching fish on multiple occasions. This would then lead it to getting on the removal list. Sea lions that are highly effective but are difficult to identify (e.g., due to foraging in hard to view areas or outside the BRZ, or without presenting dorsal surface for brand identification) would never be identified as such and therefore not get on the removal list.

  - Are there animals that are not susceptible to trapping for removal purposes?

This might be assessed by cross-referencing brand resights of animals seen foraging in the BRZ against brand resights of animals captured in the traps. If there are some animals that are consistently seen foraging or hauled out elsewhere but not in the traps then they would not be susceptible to current removal methods. This assessment has not yet been conducted due to limited staff resources.

  - Are there individuals that are hard to capture and are having a big impact?

See pervious two responses. While not directly answering the question, the following is a pivot table showing the removal year crossed with the year it was added to the removal list (appendix year). The "(blank)" column represents animals that were on the removal list but have never been removed.

Count of Serial Number	Removal year										
AppendixYear	2008	2009	2010	2011	2012	2013	2014	2015	2016	(blank)	Grand Total
2008	8	13	6	1						45	73
2009		2	3							9	14
2010			5		5		1			17	28
2012					8	4	1		1	10	24
2013							6	2		8	16
2014							7	8	1	10	26
2015								22	25	21	68
2016									32	30	62
Grand Total	8	15	14	1	13	4	15	32	59	150	311

  - Data showing whether removed animals are repeat animals, juveniles or new to Bonneville.

This is difficult to assess accurately since nearly all branded animals seen at Bonneville Dam were branded as sub-adults or adults that may have visited the dam prior to having been branded and would thus falsely appear to be "new" subsequent to branding. Only in the case of animals branded as pups at San Miguel Island that show up at Bonneville can we assess age at recruitment and there have only been a small number of such animals. At the EMB where we

have a much larger sample size of San Miguel Island brands, the youngest we have seen animals is age 3 but the majority are >6 years of age.

- If repeat animals, how many years were they observed at the dam?

See responses above. In general, the average number of years an animal has been seen at the dam has been going down due to removal program.

- How many fish has the Corps seen them eating?

Data on documented kills by removed animals exists in the USACE database but this assessment has not yet been conducted due to limited staff resources. However, the following table gives some idea of the capacity for individual predation rates:

Table 12. Maximum number of salmonids observed consumed by an individual California sea lion (CSL) at Bonneville Dam between January 1 and May 31, 2002 to 2016.

Year	Maximum Number of Salmonids Caught by an Individual CSL	Percentage of Salmonid Catches Attributed to Individual CSLs
2002	51	85.6%
2003	52	67.7%
2004	35	54.3%
2005*	11*	8.9%*
2006	79	43.0%
2007	64	28.1%
2008	107	42.6%
2009	157	62.1%
2010	198	51.9%
2011	125	41.7%
2012	41	53.0%
2013	59	42.1%
2014	59	26.3%
2015	28	14.1%
2016	25	12.5%

* In 2005 the observation season began late therefore we didn't have an opportunity to train observers on individual CSL identification.

Source: Draft Evaluation of pinniped predation on adult salmonids and other fish in the Bonneville Dam Tailrace, 2016. U.S. Army Corps of Engineers.

As noted before, however, estimates such as these are biased low since the probability of detecting and attributing a predation event to a specific individual is less than one. It is common to see a branded animal consume a fish but not be able to read the complete brand.

- Impact of changes in the timing of approval to remove (paperwork processing efficiencies)

The impact of changes to paperwork processing was considerable. Changing from a practice of updating the removal list 3-4 times per season to 3-4 times per month was largely responsible for the large number of removals in 2016.

- What would make the program successful?

The States believe that the Section 120 implementation under the 2012 LOA was successful in reducing predation losses to threatened and endangered salmonids (see bioenergetic modeling results above) and in reducing future recruitment of new CSLs into the nuisance population at Bonneville Dam (*sensu* Schakner et al. 2016[6]). However, that States also believe the program can be made more successful. Short of declaring that all CSLs in the BRZ are significant salmonid predators, the States believe the following would make the current 2016 Section 120 LOA implementation more successful:

1. Eliminate the hazing criteria. It has been demonstrated that current hazing practices have a negligible effect on sea lions at Bonneville Dam and at other similar situations (e.g., Ballard Locks, Willamette Falls). While eliminating the hazing requirement would not necessarily result in increased program effectiveness directly, it would allow for limited resources to be redirected to potentially more productive efforts.

2. Eliminate the 1-salmonid criteria. Over a decade of observations and dietary analyses has shown that CSLs, while they occasionally supplement their diet with other prey, are at Bonneville Dam to prey on salmonids. In addition, since the probability of detecting and attributing a predation event to an identifiable animal is less than one, meeting the 1-salmonid criteria really means that the animal has likely already consumed multiple unobserved fish.

3. Modify the 5-day criteria. We suggest modifying the 5-day for observing a sea lion at Bonneville Dam to 3 days in the same field season or 2 days over any two field seasons, whichever comes sooner.

    a. Since the probability of detecting a sea lion is less than one, then meeting a 3-observed-day requirement in effect likely meets a 5-estimated-day requirement.

    b. If an animal returns to Bonneville Dam in two or more seasons then it has in fact "recruited" into the nuisance population and additional days or other criteria are superfluous.

4. Increase funding. Increased funding for additional project staff could add 1-2 days of trapping and removal opportunities per week (over the current 2-3 days per week).

[6] http://rspb.royalsocietypublishing.org/content/283/1844/20162037