2013 FIELD REPORT:

EVALUATION OF PINNIPED PREDATION ON ADULT SALMONIDS AND OTHER FISH IN THE BONNEVILLE DAM TAILRACE, 2013

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EXCECUTIVE SUMMARY

The adjusted salmonid consumption estimate by pinnipeds in the Bonneville Dam tailrace for the period January 1 through May 31, 2013 was 2,928, which is slightly higher than last year, but still lower than any year since 2003. The California sea lion portion of that estimate (1,497) was also slightly higher than last year, although it is the second lowest observed since the first year observations began in 2002. However, the Steller sea lion component (1,431) continues the trend of increasing every year since 2002. The adjusted white sturgeon consumption estimate (635), exclusively by Steller sea lions in 2013, was only 20%-50% of that observed during the past five years. Whether this was due to a lack of sturgeon abundance or switching prey preference to salmonids is unknown. Predation during October through December 2012 was similar overall to 2011, other than there were a few California sea lions present in 2012 and sturgeon predation was about half that seen in 2011.

The daily average abundance of California sea lions in 2013 (3.0 per day) was similar to last year (3.2 per day) both of which are the lowest since 2002. However, the daily average abundance of Steller sea lions in 2013 (13.0) continued to be higher than that for California sea lions for the fourth consecutive year.

Sea lion exclusion devices (gates) continued to be effective at keeping sea lions out of the fishways. Non-lethal hazing with pyrotechnics from both the dam face and by boat continued to have short term impacts at driving or keeping some sea lions away from the fishways, however, some individual sea lions were not chased away at all and continued to hunt near the dam. The states removed four California sea lions from the Bonneville Dam population in 2013.

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INTRODUCTION

The U.S. Army Corps of Engineers (USACE) has used surface observations since 2002 to evaluate the seasonal presence, abundance, and predation activities of pinnipeds, including California sea lions (*Zalophus californianus*), Steller sea lions (*Eumetopias jubatus*), and Pacific harbor seals (*Phoca vitulina*) in the Bonneville Dam tailrace (Stansell, 2004; Tackley, et al., 2008; Stansell, et al., 2010, 2011, 2012). This monitoring program is part of an ongoing effort to understand and manage pinniped predation on salmonids, particularly Endangered Species Act (ESA) listed Columbia River spring Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*O. mykiss*) in the tailrace of the dam. The USACE and partnering agencies have used a variety of deterrents and barriers to prevent predation in and around fishways and to deter predation on salmonids and other fish in the tailrace.

This report is an annual summary of monitoring and deterrence efforts implemented by or coordinated with the USACE. Agency partners included the Oregon Department of Fish and Wildlife (ODFW), the Washington Department of Fish and Wildlife (WDFW), the Columbia River Inter-Tribal Fish Commission (CRITFC), the National Oceanic and Atmospheric Administration Fisheries (NOAA), and the U.S. Department of Agriculture (USDA). Although primarily covering 2013, data from 2002 to 2012 are also presented for comparison.

OBJECTIVES:

1. Estimate the number of adult salmonids (*Oncorhynchus* sp.), white sturgeon (*Acipenser transmontanus*), Pacific lamprey (*Entosphenus tridentatus*), and other fish consumed by pinnipeds in the Bonneville Dam tailrace and estimate the proportion of the adult salmonid run impacted.

2. Determine the seasonal timing and abundance of pinnipeds present at the Bonneville Dam tailrace, documenting individual California sea lion (CSL) and Steller sea lion (SSL) presence and predation activity when possible.

3. Evaluate the effectiveness of pinniped deterrents and barriers used at Bonneville Dam.

4. Evaluate the effect of the CSL removal program by ODFW and WDFW on the numbers of pinnipeds present and predation rates at Bonneville Dam.

METHODS

The methods used to collect data for developing pinniped predation estimates and pinniped abundance estimates have generally remained constant every year since 2002. Changes to procedures between years have involved the number of hours of observation made each year with a trend toward more detailed data collected on specific locations of predation events, and the species of predator and prey. Methods used for surface observations, predation and abundance estimates, and assumptions made are described in more detail in Stansell (2004), Tackley et al. (2008), and Stansell et al. (2010).

SURFACE OBSERVATIONS

While surface observations are a useful tool for assessing sea lion diet at Bonneville Dam, pinnipeds can consume smaller prey underwater, so all consumption estimates and associated impacts outlined in this report should be considered minimum estimates.

Observers were stationed at each of the three major tailrace areas of Bonneville Dam: The first powerhouse (PH1), The second powerhouse (PH2), and the spillway. They used binoculars to observe and record pinniped presence, identify and record fish catches, and identify individual CSL and SSL when possible. Prey species were identified when possible and size for white sturgeon was estimated. Individual pinnipeds were identified when possible by cataloging unique physical characteristics and/or unique brand numbers. Individual identification was used to generate abundance estimates and to track individual predation and other behavioral patterns both within and among years.

In 2013, regular observations began the hour of sunrise and ended the hour of sunset with one hour breaks in the morning and afternoon, and the break hours changing each day. Observations were occasionally conducted at night and were factored into the equation for determining adjusted estimates. Night vision binoculars were used to assist in sea lion detection, counting (at haul out locations), and predation events at night. Each tailrace was divided into seven zones (Figure 1) and the location of each predation event recorded by zone.

The primary study period was from January 4 to May 31 to focus on the spring Chinook salmon passage season at Bonneville Dam. In recent years it has been noted that SSL are arriving at Bonneville Dam as early as August. In light of this early arrival we began a pilot program of observations in the fall and early winter. Fall observations were made between October 1 and December 31, 2012 to collect additional information on SSL consumption of white sturgeon and other fish in the Bonneville Dam tailrace. In 2013, regular observations began January 4 and ended May 31 and covered Mondays through Fridays. Data were interpolated for days and hours not observed. Limited observations were conducted in early January and into June but not factored into predation estimates.

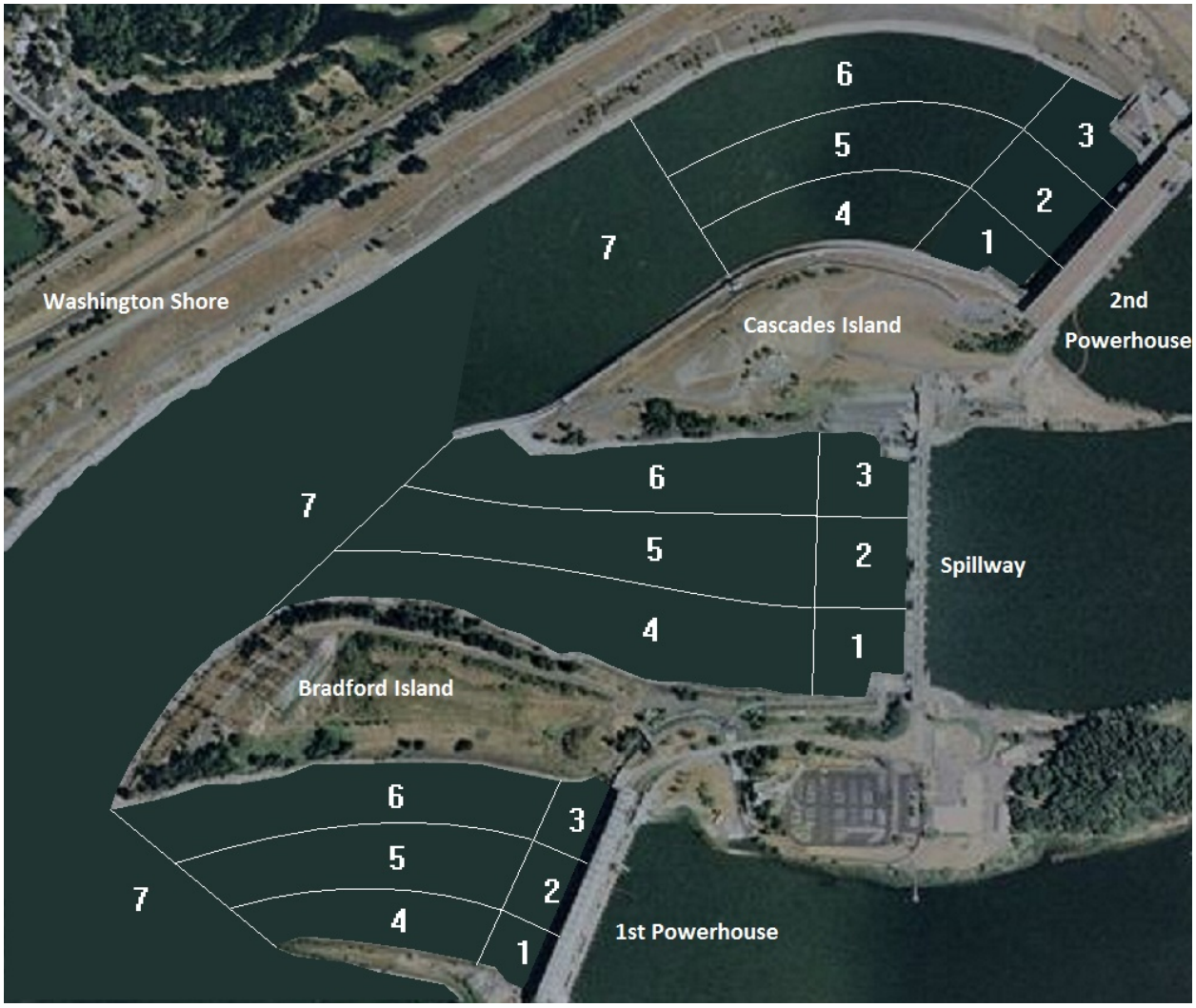

Figure 1. Primary study area and location of zones at Bonneville Dam, 2013.

PREDATION ESTIMATES

Expanded Consumption Estimates

Surface observations were used to estimate total consumption of Chinook salmon, steelhead, Pacific lamprey and white sturgeon. Since observers were not present at all times, we used interpolation at each of the tailrace areas (PH1, PH2, and spillway) to estimate adult salmonid, sturgeon, and lamprey consumption. Estimates for all three tailrace sub-areas were combined to calculate total daily estimated consumption for the Bonneville Dam tailrace. We used linear interpolation to fill in the data gaps for days on which no observations were made. All daily estimated consumption totals were added to get the total *expanded consumption estimate* for the year. The *minimum estimated impact* on salmonids passing during the observation period (expressed as percent of run) was calculated by dividing the expanded salmonid consumption estimate by the expanded salmonid consumption estimate plus the total salmonid passage count from Bonneville Dam for the January 1 through May 31 time period.

Adjusted Consumption Estimates

Expanded consumption estimates were adjusted to include unknown catches and nighttime predation. Observers were occasionally unable to identify a fish to species during a predation event. We can make more realistic estimates of salmonid and sturgeon consumption beyond the total *expanded consumption estimate* by attributing "unknown" prey to specific species based on the proportion of known prey observed consumed by each pinniped species (Stansell et al., 2010, Appendix B, Equation 2). The daily observed catch distributions included adult salmonids, sturgeon, American shad (*Alosa sapidissima*), northern pikeminnow (*Ptychocheilus oregonensis*), and bass (*Centrarchidae*). Lamprey and smolt (juvenile salmonids) were excluded from this proportional allocation, as we determined that their distinctive sizes and shapes made them extremely unlikely to be recorded as unidentified fish. The proportionally split consumption totals for "unknowns" for CSL and SSL were added to the expanded consumption estimates to calculate the adjusted consumption estimate for each day. We also estimated nighttime consumption by increasing the daily estimate by 0.9% based on our night work in 2011, 2012 and 2013. This is less than the 3.5% observed in 2009 and also used for 2010 adjusted estimates (Stansell, et al., 2009). Little or no nighttime predation was observed prior to large-scale daytime hazing efforts, which began in 2006, and we felt there was some shift to nighttime predation once large-scale daytime hazing began. This seems to have shifted in recent years as CSL numbers have declined; however, nighttime predation is very difficult to observe and therefore is still largely an unknown factor that we most likely are underestimating.

INDIVIDUAL IDENTIFICATION

Identification of individual CSL and SSL was used to determine the number of sea lions present (daily and seasonally) and to track individual presence and predation activity. We used video and photos from digital HD video recorders equipped with 30X optical zoom lenses, field sketches, and observer notes to identify unique marks for individual CSL and SSL and to confirm identities of individuals seen by multiple observers. Individual pinnipeds were identified by noting a combination of physical characteristics such as brands, cuts, scars, lumps, color patterns, size, maturity, and also behavior. Since harbor seal presence was relatively minor at the dam, we did not attempt to identify and track individual harbor seals.

A catalog of photos and sketches of all individuals is kept and updated annually. More detailed description of the methods used to determine daily and annual pinniped abundance estimates can be found in Stansell et al., 2010.

DETERRENTS AND MANAGEMENT ACTIVITIES

In 2013, physical barriers (sea lion exclusion devices or SLEDs and floating orifice gate barriers or FOGs) were re-deployed to keep pinnipeds from entering the fishways. SLEDs were installed at PH1 on January 31, at Cascades Island on February 4, at PH2 south entrances on February 26, at PH2 north entrances on March 13, and at B branch on March 18. These dates were later than normal due to construction activities at PH2 and crane availability and staff constraints during that time. All SLEDs were removed on June 13. All were effective, and no pinnipeds were observed entering the fishways during the 2013 season.

The states re-submitted a request to NOAA for authority for lethal removal of CSL under Section 120 of the Marine Mammal Protection Act after addressing issues that the 9th Circuit Court of Appeals felt required attention. NOAA granted the states a permit to continue the removal program for 2012 through 2016. Personnel from ODFW and WDFW operated four floating sea lion traps (for details see Brown et al., 2008) at Bonneville Dam at various locations across the season. Trapped animals were branded and/or tagged (acoustic and/or GPS) and specific CSL that qualified for removal under their permit were removed from the population.

The USDA (dam-based) and CRITFC (boat-based) continued non-lethal harassment (hazing) techniques. Hazing involved a combination of acoustic, visual, and tactile non-lethal deterrents, including boat chasing, above-water pyrotechnics (cracker shells) and rubber buckshot from shotguns. Boat-based crews also used underwater percussive devices known as seal bombs. Dam-based and boat-based crews coordinated with USACE personnel, including our observers, to ensure safety and to increase the effectiveness of hazing efforts. Dam-based hazing by USDA began the first week in March and continued seven days per week through the end of May.

Boat-based hazing in 2013 was primarily conducted by personnel from CRITFC from the first week in March through mid-May. Boats operated primarily in the Bonneville Dam tailrace boat restricted zone (BRZ). Boats could not operate within 30 m of dam structures or within 50 m of fishway entrances. To minimize the impact to fish, the use of seal bombs was prohibited within 100 m of fishways, collection channels, or fish outfalls for the PH2 corner collector and smolt monitoring facility, and the use of seal bombs ceased completely in the tailrace after adult salmonid passage exceeded 1,000 fish per day at Bonneville Dam. More detailed information on boat-based hazing activities is in Wright et al., 2007 and Brown et al., 2008, 2009, 2010, 2011 and 2012.

RESULTS AND DISCUSSION

PREDATION ACTIVITY

Between January 4 and May 31, 2013, observers completed over 3,247 hours of daytime observations. During this period, observers saw pinnipeds catch and consume 2,275 fish of several species. Adult salmonids were the primary prey item, comprising 67.7% (n=1,540) of observed catches. White sturgeon, American shad and Pacific lamprey were the second, third, and fourth most commonly identified prey types, comprising 13.8% (n=314), 3.4% (n=78) and 1.7% (n=38) of total observed catch respectively. Other fish (smolts, bass, sucker (*Catostomidae*), pikeminnow) made up about 5.1% (117) of observed catch. Observers were unable to identify 8.3% (n=188) of the fish caught and consumed by pinnipeds during this period.

Between October 1 and December 31, 2012 we completed over 345 daytime hours of observation. At least four CSL were observed at Bonneville Dam in the fall of 2012 (for one day each), and a harbor seal was observed on three separate days. However, at least 12 individual SSL were observed between October and December 2012. Adult salmonids were the primary prey item, comprising 41.0% (125) of observed catches. White sturgeon were the second most commonly observed prey type consumed, comprising 32.8% (100) of the catch. Observers were unable to identify 18.7% (57) of the fish caught and consumed by SSL. Identified salmonid species caught were 34 Chinook, 55 steelhead, 34 coho (*Oncorhynchus kisutch*), and 2 chum (*Oncorhynchus keta*). All non-salmonid predation observed were by SSL. Adjusted estimates of fall/winter predation for 2011 and 2012 can be seen in Appendix D.

Predation on Adult Salmonids

In 2013, the expanded adult salmonid consumption estimate for the Bonneville Dam tailrace observation area was 2,714 or 2.2% of the adult salmonid run at Bonneville Dam from January 1 through May 31. Accounting for unidentified fish, the adjusted estimated consumption was 2,928 (or 2.4% of the run) (Table 1). A progressive series of tables, broken out for CSL and SSL, showing estimated salmonid consumption (interpolated for hours and days not observed), adjusted salmonid consumption (factoring in unidentified fish caught), and finally adding a nighttime consumption factor after hazing began (in 2006) is presented in Appendix A. The estimated percent of the run consumed declined from a high of 4.2% in 2007 through 2012 (Table 1). This decline is largely explained by an upward trend in the salmonid run size for 2007 through 2010 (Figure 2). In 2013 there was a small increase in the percent of the run consumed. Both CSL and SSL took about the same number of salmonids in 2013, 51.2% (n=789) and 48.8% (n=751) of the observed catches, respectively (Table 2). Estimated salmonid catch by SSL increased every year from 13 in 2007, 174 in 2008, 452 in 2009, 986 in 2010, 1,030 in 2011 and 1,109 in 2012 to 1,312 in 2013. The drop in CSL salmonid predation in 2011 and 2012 relative to previous years and the continuing rise in SSL salmonid predation each year can be seen in Figure 3.

Table 1. Consumption of salmonids by CSL, SSL, and harbor seals at Bonneville Dam tailrace, from surface observations conducted between 2002 and 2013. Total salmonid passage counts include all adult salmonids that passed Bonneville Dam from January 1 through May 31.

Year	Bonneville Dam salmonid passage (Jan. 1-May 31)	Expanded salmonid consumption estimate		Adjusted salmonid consumption estimate	
		Estimated consumption	% of run (Jan. 1 to May 31)	Estimated consumption	% of run (Jan. 1 to May 31)
2002	284,732	1,010	0.4 %	1,010	0.4 %
2003	217,934	2,329	1.1 %	2,329	1.1 %
2004	186,771	3,533	1.9 %	3,533	1.9 %
2005	81,252	2,920	3.4 %	2,920	3.4 %
2006	105,063	3,023	2.8 %	3,401	3.1 %
2007	88,474	3,859	4.2 %	4,355	4.7 %
2008	147,558	4,466	2.9 %	4,927	3.2 %
2009	186,056	4,489	2.4 %	4,960	2.7 %
2010	267,167	6,081	2.2 %	6,321	2.4 %
2011	223,380	3,557	1.6%	3,970	1.8%
2012	171,665	2,107	1.2%	2,360	1.4%
2013	120,619	2,714	2.2%	2,928	2.4%

Table 2. CSL and SSL predation on adult salmonids at Bonneville Dam, from January 1 through May 31, 2013.

Predator		Expanded Salmonid Consumption estimate		Adjusted Salmonid Consumption estimate	
	Observed Salmonid Catch	Estimated consumption	% of Run (1/1 to 5/31)	Estimated consumption	% of Run (1/1 to 5/31)
CSL	789	1,402	1.1 %	1,497	1.2 %
SSL	751	1,312	1.1 %	1,431	1.2 %

Chinook salmon were the most commonly identified prey species, comprising 97.5% (n=1,424) of observed adult salmonid catch in 2013. The expanded Chinook salmon consumption estimate for the Bonneville Dam tailrace in 2013 was 2,525 or 1.6% of the Chinook salmon run (including jacks) from January 1 through June 15 (Table 3). Note that this time period includes the defined Columbia River spring Chinook salmon passage season at Bonneville Dam (through June 15), which extends beyond the period during which sea lions are normally present. Keefer et al. (2012) used radio-telemetry and our observational data between 2002 and 2010 to identify specific salmonid populations at risk due to predation on early-timed passage of upriver stocks. Those populations identified with the highest risk included endangered/threatened stocks from the Clearwater and Salmon rivers in Idaho, the Umatilla and Deschutes rivers in Oregon, and the Icicle River in Washington. The higher proportional impact to the early passing Chinook salmon stocks by CSL averaged over the past 10 years (Figure 4) was not evident for 2013 (Figure 5).

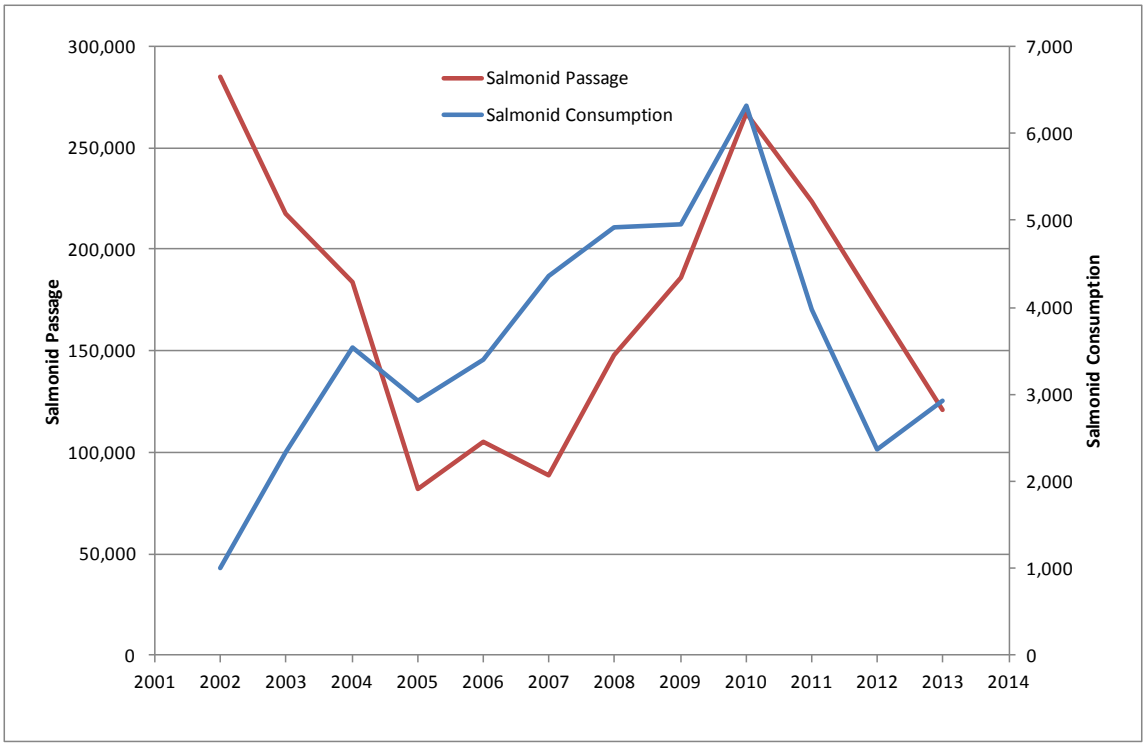

Figure 2. Annual adjusted estimate of salmonid consumption by pinnipeds and total salmonid passage through Bonneville Dam for the period January 1 through May 31.

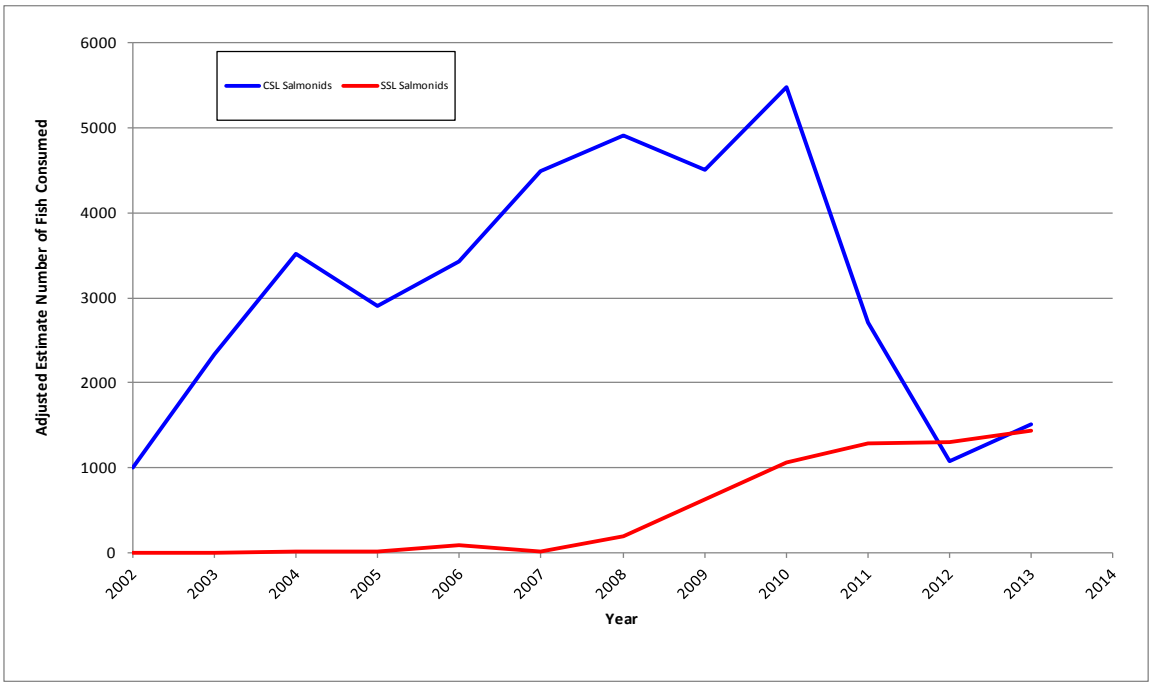

Figure 3. Salmonid consumption estimates adjusted for "unknown" and nighttime predation by CSL and SSL at Bonneville Dam, 2002-2013.

Table 3. Consumption of spring Chinook salmon by pinnipeds at Bonneville Dam between 2002 and 2013.

Year	Chinook salmon passage (Jan. 1 – June 15)	Expanded Chinook consumption estimate	Percent of Chinook run (Jan. 1 – June 15)
2002	316,468*	880[‡]	0.3 %
2003	247,059	2,313	0.9 %
2004	210,569	3,307	1.5 %
2005	102,741	2,742[†]	2.6 %
2006	130,014	2,580	1.9 %
2007	101,068	3,403	3.3 %
2008	174,247	4,115	2.3 %
2009	229,271	3,997	1.7 %
2010	293,662	5,757	2.0 %
2011	272,469	3,298	1.2%
2012	196,667	1,750	0.9%
2013	155,729	2,525	1.6%

* Fish counts did not start until March 15 in 2002. Chinook passage from January 1 through March 15 was minimal in all other years.

[‡] From March 15 through April 25, used fish passage count split between Chinook salmon and steelhead to estimate Chinook proportion of unidentified salmonid catch. After April 25, we used observed catch distribution to divide unidentified salmonid consumption.

[†] In 2005, regular observations did not start until March 18.

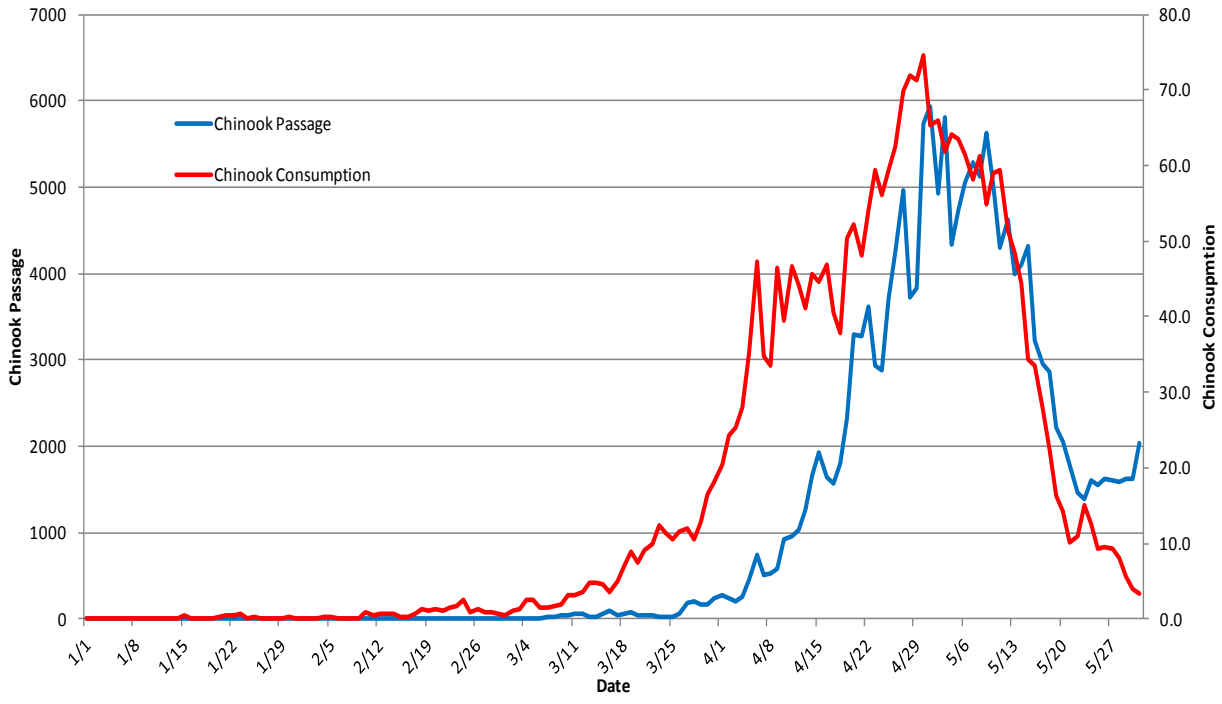

Figure 4. Mean daily Chinook consumption by CSL and mean daily Chinook passage at Bonneville Dam, 2002-2013.

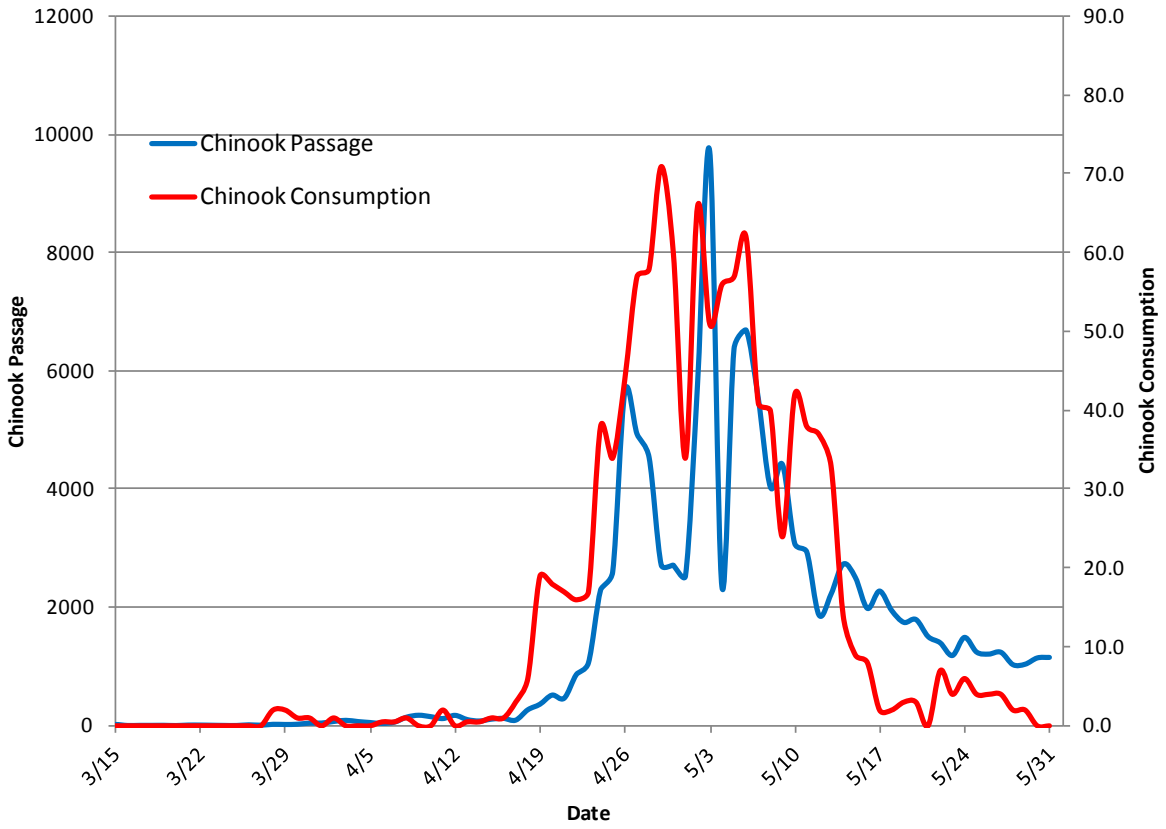

Figure 5. Mean daily Chinook consumption by CSL and mean daily Chinook passage at Bonneville Dam, 2013.

Steelhead comprised 7.5% (n=116) of observed adult salmonid catch in 2013. Steelhead, which are present in the Bonneville Dam tailrace throughout the winter and spring months, comprised the majority of salmonid catches prior to the onset of the spring Chinook salmon run. During the last few years, SSL were often observed swallowing steelhead whole, suggesting that they could consume steelhead and Chinook salmon jacks entirely below the surface. All consumption estimates provided are minimum estimates, but it should be noted that because the larger SSL can swallow steelhead whole, predation by SSL may be underestimated more than CSL predation by the current surface observation methods.

The adjusted estimate of salmonid predation during the fall of 2012 by SSL was 389 salmonids. Broken out by species, the adjusted estimates are 105 fall Chinook, 184 steelhead, 94 coho, and 6 chum (Appendix D). This is about 0.6% of the salmonids passing Bonneville during the same time period, which is the same as seen in 2011.

Predation on White Sturgeon

In 2013, the expanded white sturgeon consumption estimate for our study area was 552. This number is low compared to recent years. In 2011 the expanded estimate was 2,178 and in 2012 the estimate was 2,227 (Table 4). When unidentified catch was divided proportionally according

to daily catch distributions and added to the expanded sturgeon consumption estimate, the adjusted consumption estimate was 635. White sturgeon were the second most commonly observed prey for SSL with twice as many Chinook being taken than sturgeon for the first time since our observations began. All of the observed sturgeon catches in 2013 were by SSL. Predation on sturgeon dropped off dramatically after the first week of April when spring Chinook salmon began to show up and became the preferred prey of both SSL and CSL by mid-April (Figure 6).

Table 4. Consumption of white sturgeon by pinnipeds at Bonneville Dam from 1 January through 31 May, 2005 to 2013.

Year	Total Hours Observed	Observed Sturgeon Catch	Expanded Sturgeon Consumption estimate	Adjusted Sturgeon Consumption estimate
2005	1,108	1	N/A	N/A
2006	3,647	265	315	413
2007	4,433	360	467	664
2008	5,131	606	792	1,139
2009	3,455	758	1,241	1,710
2010	3,609	1,100	1,879	2,172
2011	3,315	1,353	2,178	3,003
2012	3,404	1,342	2,227	2,498
2013	3,247	314	552	635

An estimated 351 sturgeon were consumed by SSL in the Bonneville Dam tailrace between October 1 and December 31, 2012. Adjusting for unidentified prey, the estimated total sturgeon consumed in the fall/winter was 456. This was almost half the estimated sturgeon predation estimated in 2011 (Appendix D). More sturgeon predation occurs well below the Bonneville Dam tailrace area, but no systematic observation program has been conducted.

When possible, observers estimated the lengths of sturgeon caught by pinnipeds in one foot increments. The estimated lengths of sturgeon caught between 2006 and 2013 ranged from less than 2 ft (0.6 m) to over 7 ft (2.7 m), but 80.4% of sturgeon lengths (n=4,371) were 4 ft (1.2 m) or shorter (Figure 7).

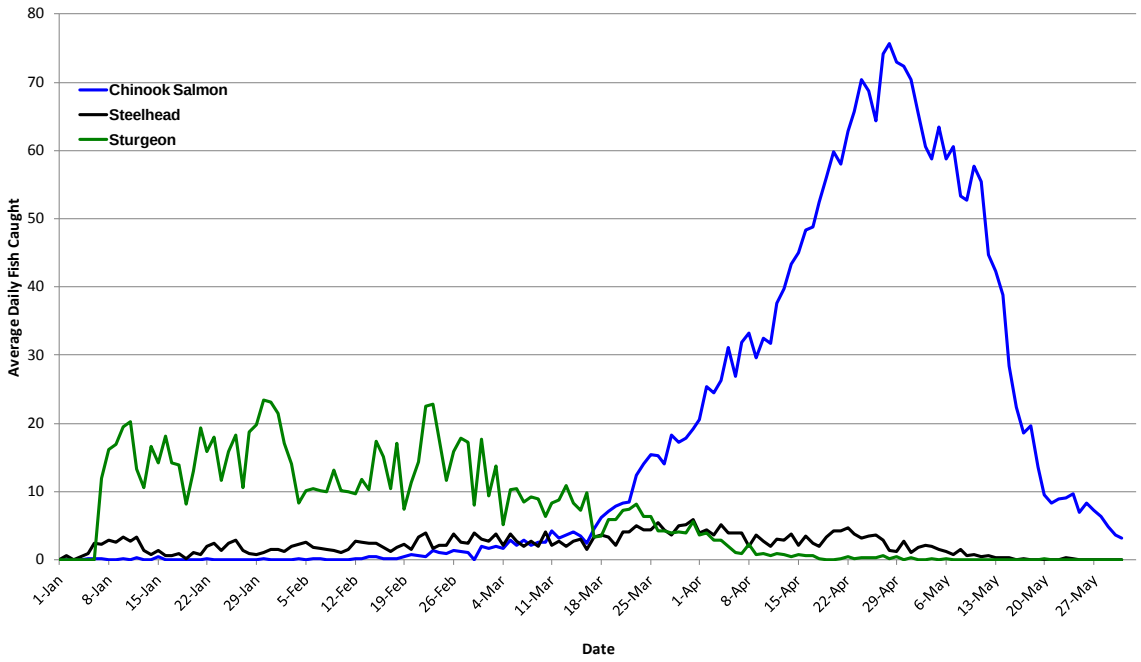

Figure 6. Daily average estimated Chinook salmon, steelhead, and white sturgeon consumption by both SSL and CSL at Bonneville Dam from January 1 through May 31, 2006 to 2013.

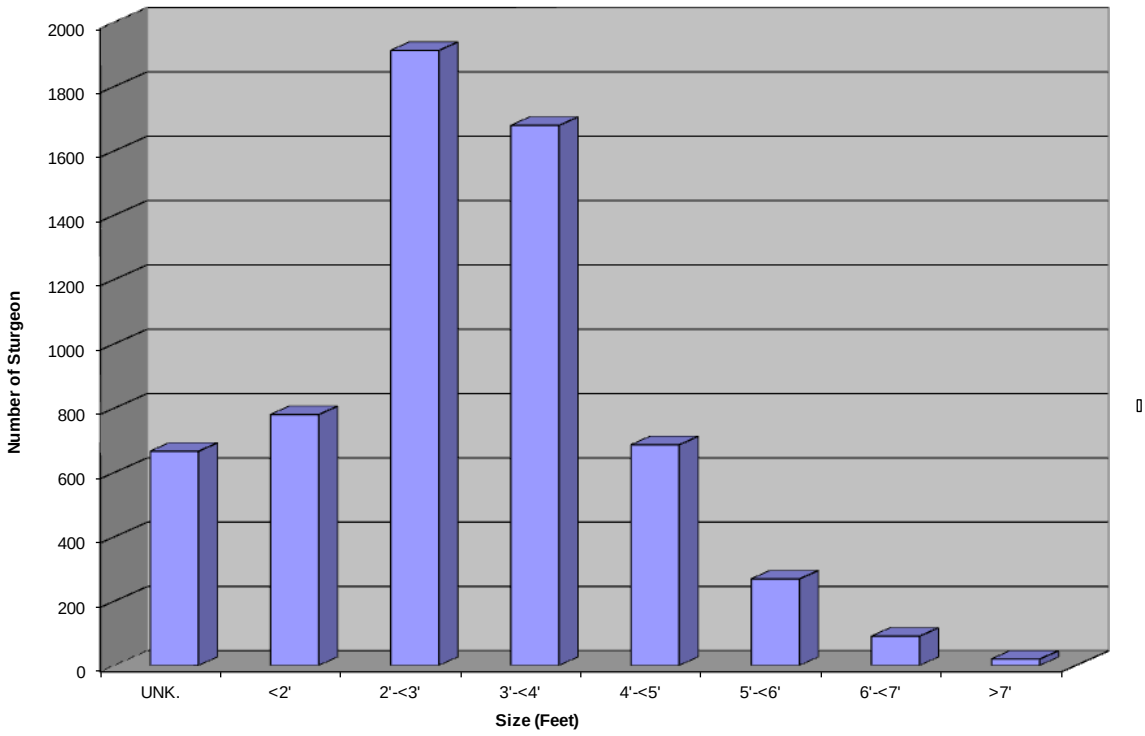

Figure 7. Estimated lengths of white sturgeon consumed by SSL and CSL at Bonneville Dam, from January 1 through May 31, 2006 to 2013.

Predation on Pacific Lamprey

In 2013, the expanded Pacific lamprey consumption estimate was 66, one of the lowest estimates of the previous 10 years of observation (Table 5). CSL made 20 of the 38 observed lamprey catches in the Bonneville Dam observation area. The lamprey proportion of total observed catch was 2.5%, continuing the trend of low lamprey predation compared to 2003-2006. Due to the small body size and presumed vulnerability of lamprey to predation, our surface observation approach may significantly underestimate actual predation on lamprey. However, this underestimate should be similar among years. Lamprey passage numbers have decreased in general since 2006 at Bonneville Dam (Figure 8). The lamprey passage season is mid-May through October.

Table 5. Consumption of Pacific lamprey by pinnipeds at Bonneville Dam from January 1 through May 31, 2002 to 2013.

Year	Total Hours Observed	Observed Pacific Lamprey Catch	Expanded Pacific Lamprey Consumption estimate	Percent of Total Observed Fish Catch
2002	662	34	47	5.6%
2003	1,356	283	317	11.3%
2004	553	120	816	12.8%
2005	1,108	613	810	25.1%
2006	3,647	374	424	9.8%
2007	4,433	119	143	2.6%
2008	5,131	111	145	2.0%
2009	3,455	64	102	1.4%
2010	3,609	39	77	0.7%
2011	3,115	16	33	0.4%
2012	3,404	40	79	1.4%
2013	3,247	38	66	2.5%

Location of Predation Events

In 2013, consumption of Chinook by CSL and SSL per zone was similar across the tailrace. However, CSL had more predation in the spillway tailrace zones than SSL (Appendix Figures B-1 and B-2). The most obvious change between years was the increased proportion of catch by CSL in the spillway tailrace in 2013 compared to previous years (Stansell et al., 2011 and 2012). Predation on sturgeon by SSL was primarily in zone 7 of PH1 and the spillway tailraces (Appendix Figure B-3). This preponderance of downstream sturgeon predation indicates we are likely underestimating the number of sturgeon consumed, as many of these events are occurring at the extreme edge of our viewing area. For example, smaller sturgeon consumed in zone 7 of PH2 could likely go unseen (typically sturgeon less than 4 feet were completely consumed in 1-5 minutes), whereas larger sturgeon can be seen consumed as the SSL drift downstream into zone 7 of the spillway tailrace. We have noted larger sturgeon being fed upon by multiple individuals

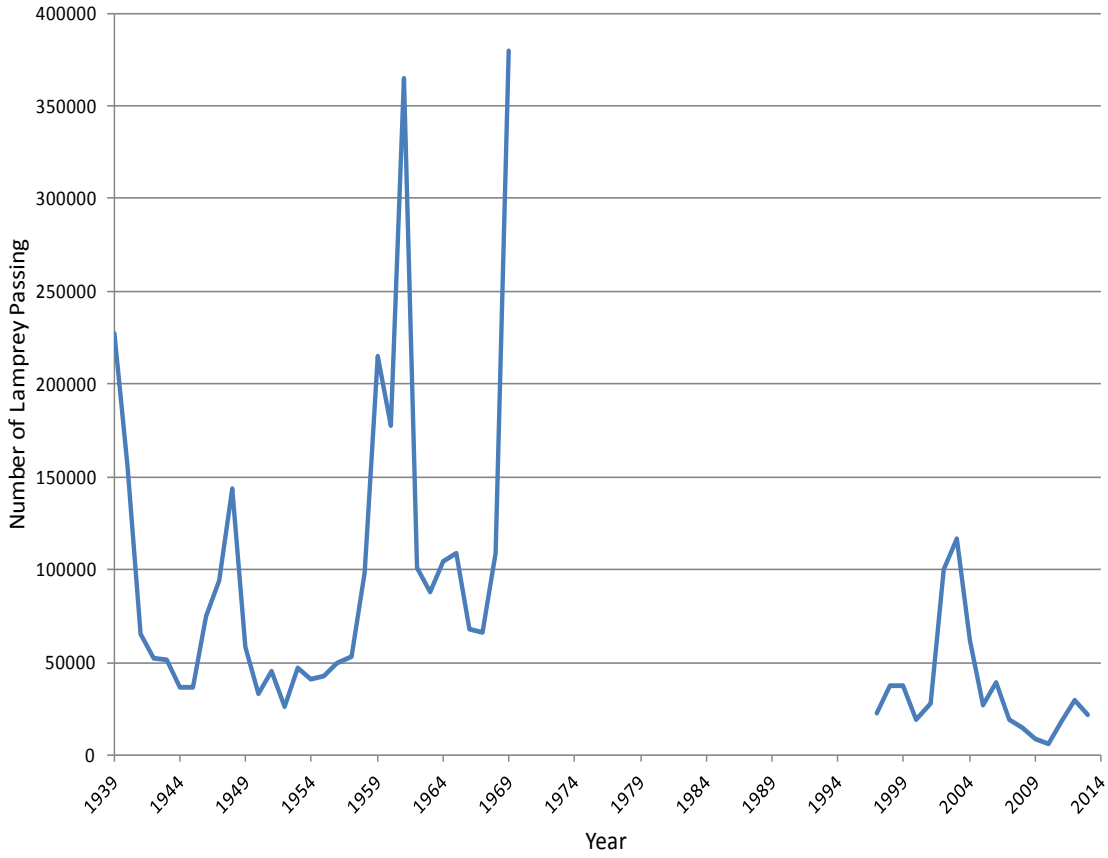

Figure 8. Lamprey daytime passage estimates at Bonneville Dam from 1939 to 2013. Lamprey were not counted at Bonneville Dam from 1970 to 1996. Data for 2013 through October 28.

for as long as an hour or more. As always, the recorded zone is the location where the predator is first seen with the fish, and it is entirely possible the fish was caught farther upstream and dragged downstream underwater into other zones before being seen.

Predation on salmonids primarily occurred in the PH2 tailrace before 2006 but has alternately predominated between PH1 and PH2 since 2007, possibly due to hazing activities, powerhouse flow, or access to haul out and rafting locations (Figure 9). In 2013, it was almost equal at all three tailraces. It is not due to salmonid passage changing between powerhouses, as PH2 has consistently passed more fish (59-77%) each year. Sturgeon were primarily observed being consumed at the spillway from 2006-2008; however, more had been seen consumed at PH2 since then until this year when the spillway saw more sturgeon predation again (Figure 10).

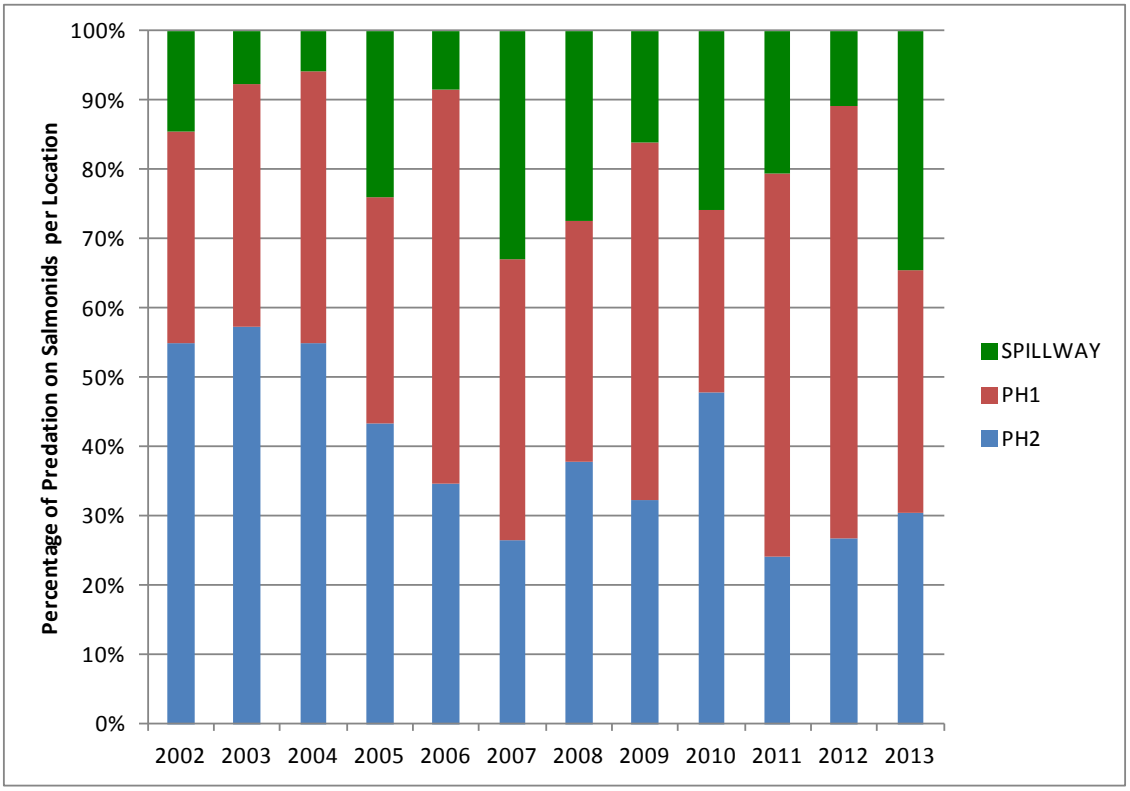

Figure 9. Annual percentage of predation on salmonids by pinnipeds per tailrace location.

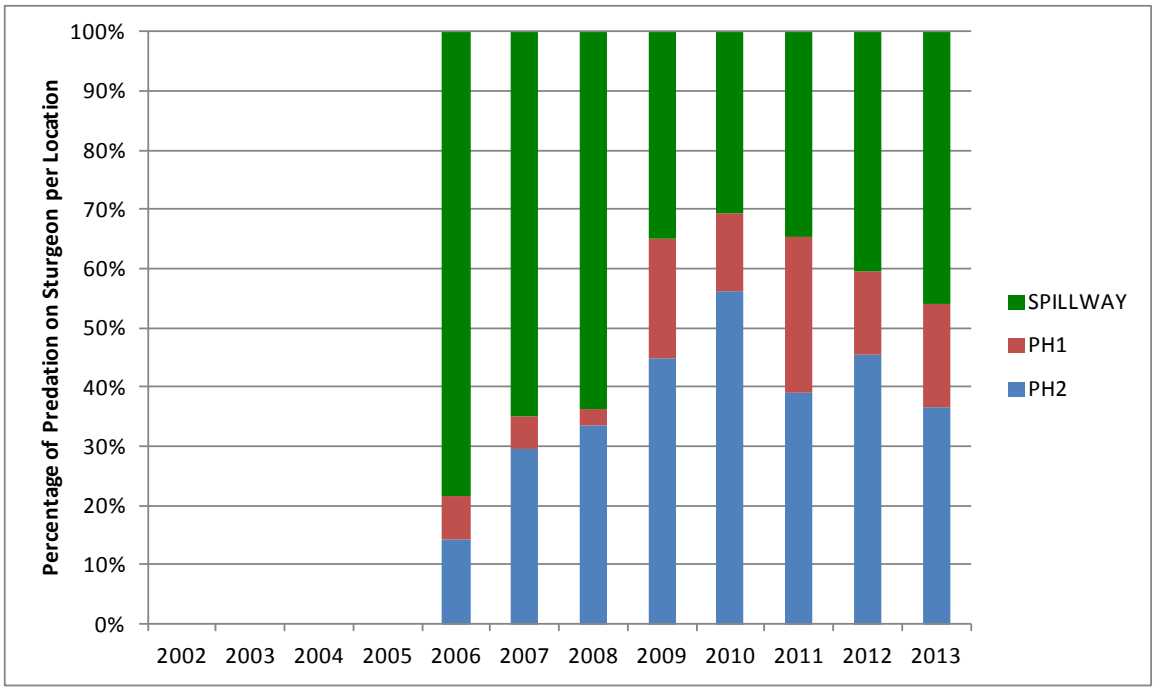

Figure 10. Annual percentage of predation on sturgeon by pinnipeds per tailrace location.

Night Observations

Twenty-nine hours of nighttime observations were made on nine nights in 2013. We only observed two salmonids and five unidentified fish being consumed, all but two during the crepuscular hours which are accounted for already by our daytime expansion equations. Although data for previous years (Stansell, et al., 2009) suggested an additional 3.5% of predation events could occur after dark, we found nighttime predation accounted for only an additional 0.9% in 2011 (Stansell, et al., 2011), and this is the factor we used for 2012 and 2013 as it seemed more realistic than the near 0% we saw in 2012 and 2013 with our small sample size. Actual predation at night could have been more, but we did not see any evidence of this using our night-vision binoculars. Glare from dam lighting, power tower lighting, highway lights, and poor weather conditions all combined to make viewing at night difficult. Predation by SSL tends to be fast, quiet, and typically farther downstream than CSL predation, so we could be missing more nighttime predation than in the past. Predation estimates for salmonids adjusted to include nighttime predation estimates are given in Appendix A.

Additional Observations

We made occasional observations outside the standard tailrace viewing area. Sixteen hours over eight different days were observed at the mouth of Tanner Creek below Bonneville Dam where pinnipeds were often seen hunting. During those hours, CSL were observed to consume four Chinook, one steelhead, and one lamprey. Also, SSL were observed to consume three Chinook, one sturgeon, and one unidentified fish. These predations were not expanded or used in the total predation estimates given elsewhere in this report.

One CSL (B325) was documented to have passed through the navigation lock upstream into the forebay on April 15, 2011. He has been identified numerous times at The Dalles Dam and on a private dock at The Dalles marina since then and is still upstream of Bonneville Dam as of this report (about 2 ½ years). In 2012, we were able to document the CSLs C014, U95, and a small unbranded CSL (not B325) also upstream of Bonneville Dam and have had numerous confirmations of two branded and one unbranded CSL (in addition to B325) still being in the Bonneville Pool as of this report. One unbranded SSL (S127) briefly appeared in the Bonneville Dam forebay but he was observed back downstream the following week. In another incident, a sea lion was observed in the lock when filling for a downstream barge, and the operator flushed the lock and refilled, preventing the sea lion from being released into the forebay.

Bonneville project has a policy to keep the downstream navigation lock gates closed at all times except for the few minutes it takes for a barge to enter or exit the locks. This seems to be helping, although it is not 100% effective. The states deployed two traps in the Bonneville Pool after the 2013 spring season in an attempt to catch the sea lions, however, as of yet, they have not been seen to use the traps to haul out on.

PINNIPED ABUNDANCE, RESIDENCE TIMES, AND RECURRENCE

The estimated number of individual pinnipeds observed at Bonneville Dam in 2013 was 136, higher than last year but only the third highest since observations began in 2002 (Table 6). SSL numbers increased a bit in 2013 to 80 individuals. The maximum of 41 SSL observed on one day in 2013 was higher than the past two years but not as high as the 53 SSL seen in 2010. CSL numbers increased in 2013 to 56 (excluding four upstream of Bonneville dam). The maximum number of CSL seen on any one day was 21 this year. This year was similar to 2010 in that record numbers of CSL were seen at the east mooring basin in Astoria (Matt Tennis, personal comm.) and many younger CSL showed up at Bonneville which were not repeats. No harbor seals were observed this year at Bonneville (although one was seen on four separate days in December). As in previous years, hazing activity typically resulted in changes in behavior (e.g. more time below the water surface, less time with backs and unique markings exposed, etc.) which made identification of individuals challenging. These abundance figures should be considered minimum estimates.

Table 6. Minimum estimated number of individual pinnipeds observed at Bonneville Dam from 2002 to 2013.

	CSL	SSL	Harbor seals	Total pinnipeds
2002	30	0	1	31
2003	104	3	2	109
2004	99	3	2	104
2005*	81	4	1	86
2006	72	11	3	86
2007	71	9	2	82
2008	82	39	2	123
2009	54	26	2	82
2010	89	75	2	166
2011	54	89	1	144
2012	39	73	0	112
2013	56	80	0	136

* Regular observations did not begin until March 18 in 2005.

Daily pinniped abundance peaked in late April 2013 (Figure 11), primarily due to SSL numbers. The highest number of pinnipeds counted on any one day in 2013 was 55 (April 29), which was higher than the past two years (Figure 12). Mean daily number of pinnipeds present was 16.2 in 2013, higher than last year but lower than most other years since 2007 (Figure 12). The CSL component (3.0 per day) shows far fewer animals present daily on average than we have seen since 2002 and the maximum seen on any one day (21), although higher than last year, was lower than any other year since 2002 (Figure 13). However, SSL were present in higher numbers this year (13.1 per day) and continues the trend of increasing presence of SSL at Bonneville Dam (Figure 13).

The most number of days an individual CSL was observed at Bonneville Dam was 16 days in 2013, the lowest since 2002 (Figure 14). The first CSL was observed on January 15 in 2013; however, there were only a few sporadic sightings of CSL until mid-March when CSL began showing up in numbers and staying. Most of the individuals returning multiple years have been

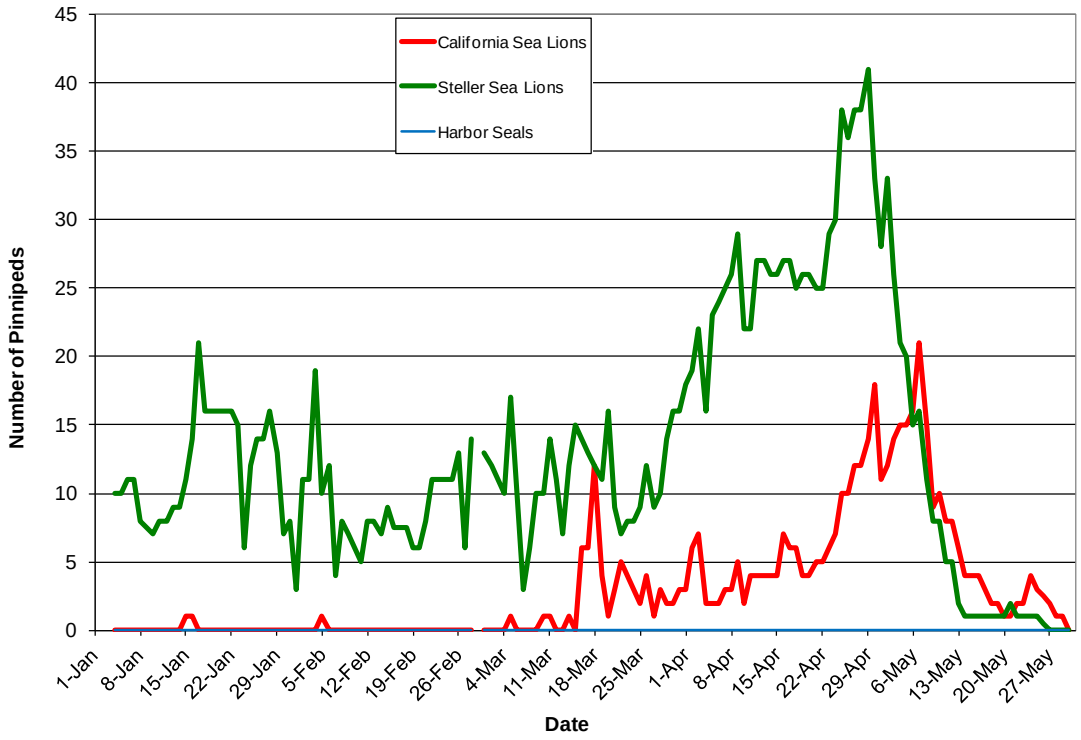

Figure 11. Daily abundance estimates for CSL, SSL, and harbor seals at Bonneville Dam from January 1 through May 31, 2013.

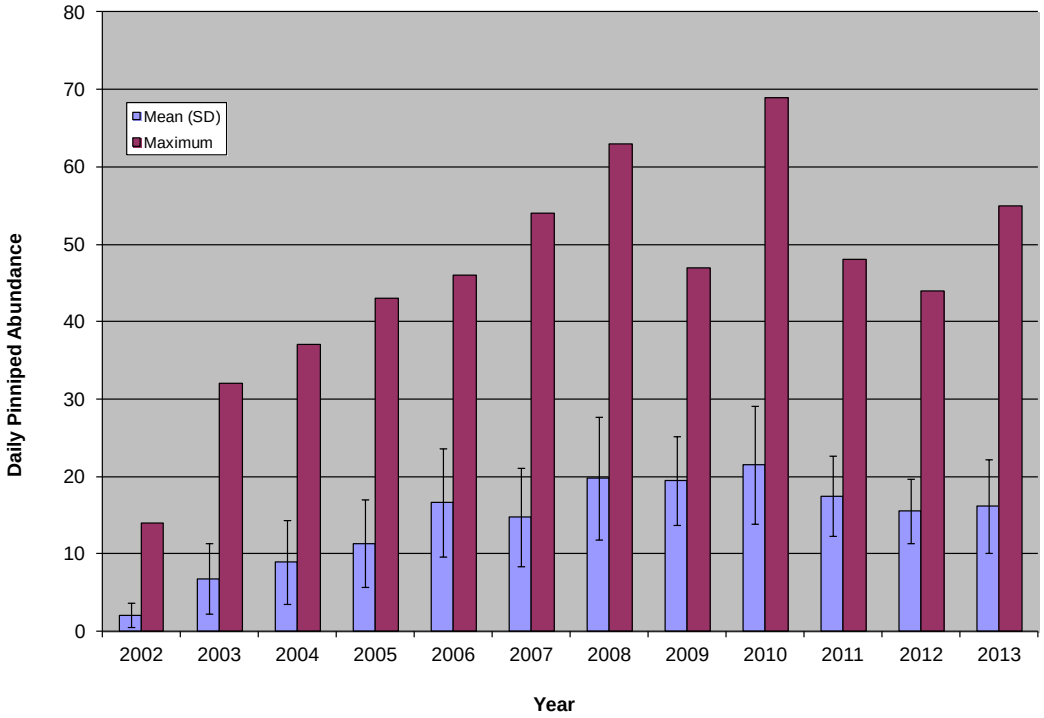

Figure 12. Mean, standard deviation, and maximum daily estimated number of pinnipeds present at Bonneville Dam between January 1 and May 31, 2002 to 2013.

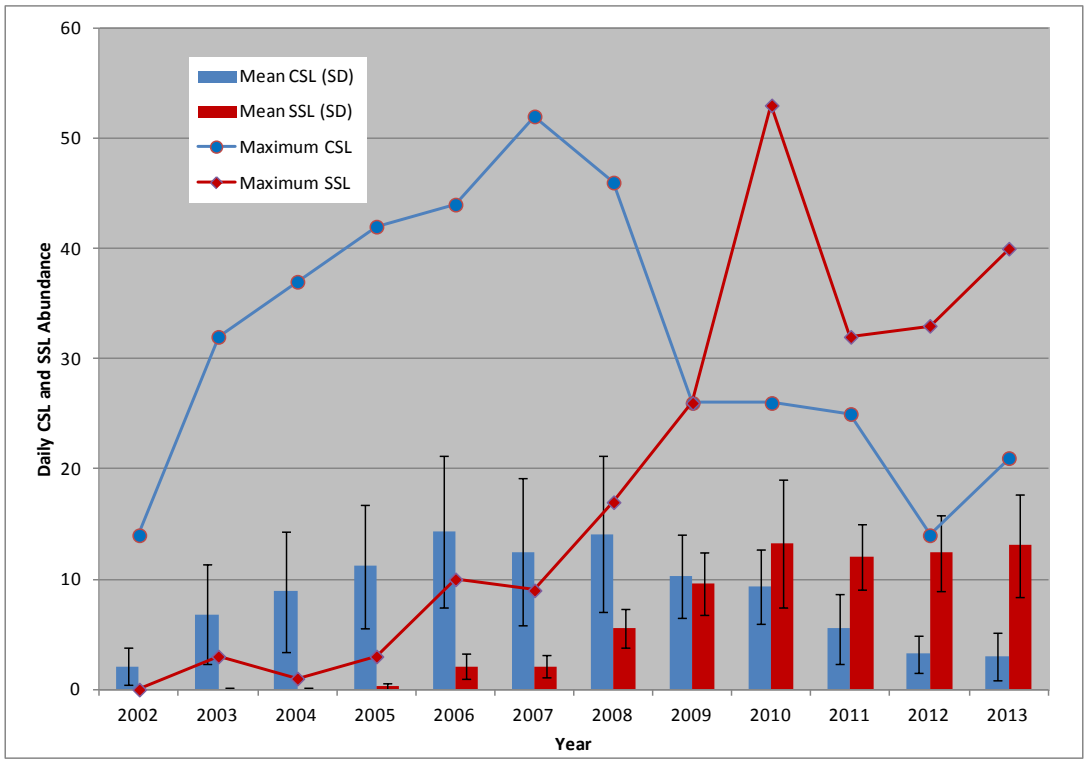

Figure 13. Mean, standard deviation, and maximum daily estimated number of CSL and SSL present at Bonneville Dam between January 1 and May 31, 2002 to 2013.

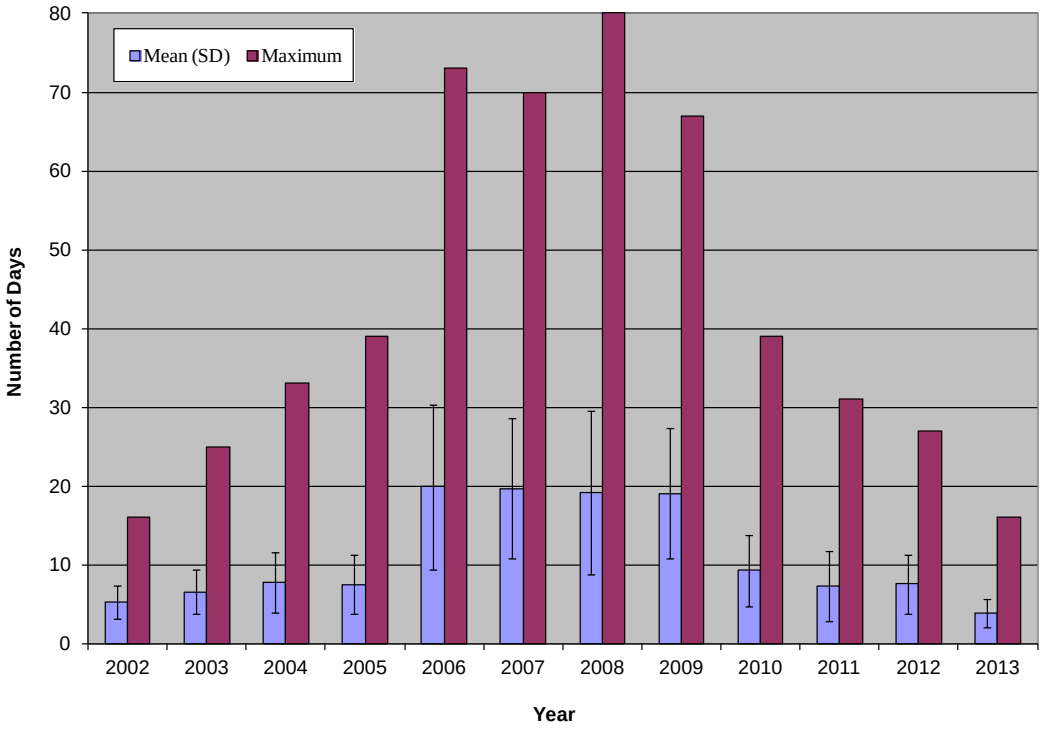

Figure 14. Mean, standard deviation,and maximum number of days individually identified CSL were observed at Bonneville Dam between January 1 and May 31, 2002 to 2013.

removed by the states over the previous five years, and this may account for the trend of most individuals now arriving later in the season and spending less time at Bonneville Dam.

A few CSL not previously identified continue to show up each year. Of the 51 highly identifiable animals observed in 2013, 35 (68.6%) were new additions to that category (including 14 branded and 10 more given brands while at Bonneville). The percentage of highly identifiable CSL returning each year was at least 19.2%, 51.2%, 77.1%, 62.3%, 65.6%, 66.2%, 69.8%, 34.6%, 64.6%, 64.1%, and 31.4% for 2003 through 2013, respectively. This year was similar to 2010 in which more new CSL were identified than returning individuals (discussed in Stansell et al., 2011). We have observed at least 169 individual CSL that have returned for one or more years to Bonneville Dam (Table 7).

Table 7. Number of years that individually identified CSL and SSL were observed at Bonneville Dam between 2002 and 2013 and the number that have been removed. Individuals present for less than one year (<1) were new animals identified in 2013. Known dead are those branded CSL that have been identified from carcass recoveries.

Number of years observed	All identified CSL	All identified SSL	Listed for Removal CSL	Removed/Known Dead CSL
8	6	0	6	4
7	4	2	4	2
6	1	6	1	0
5	19	9	19	7
4	25	9	21	7
3	47	18	30	16
2	67	41	40	15
1	293	143	36	13
<1	47	37	11	0

DETERRENTS AND MANAGEMENT ACTIVITIES

Physical Barriers

There were no sea lions observed inside the fishways, nor did any observers note any sea lions attempting to get through the SLEDs or FOG barriers in 2013 despite significant predation activity near dam structures. As in the previous three years, no pinnipeds hauled out on the PH2 tailrace concrete apron along Cascades Island in 2013 (barring a few single short-term events), preferring instead to rest in pods near the shoreline of Tower Island or near the traps. Concrete blocks set on the concrete apron to impede haul out at Cascades Island and encourage haul out on the traps seems to have had the effect to move the sea lions' resting area to Tower Island.

Non-Lethal Harassment

No acoustic deterrent devices were deployed in 2013 as they have proved ineffective during testing from 2006 to 2010 under the conditions prevailing near the fishway entrances.

Boat crews from CRITFC hazed up to five days a week most weeks between early March and mid-May, and their results will be presented in a separate report. USDA agents hazed from the dam on 92 days between March 1 and May 31. Table 8 shows the actual near dam hazing level for boat and dam-based hazing (data excludes weekends and boat hazing downstream of the BRZ as our observers were not present to record this information). Bird hazing (10.9 hours) may also have had some impact on pinnipeds.

Table 8. Total hours of hazing activity in the Bonneville Dam tailrace observation area in 2013. Data excludes weekends when observers were not present.

	Number of Times Hazers were Present at Least Once in an Hour		Total Time (Hours) Hazers were Present	
	Boat hazing	*Dam hazing*	*Boat hazing*	*Dam hazing*
Location				
Powerhouse 1	110	289	23.3	111.0
Powerhouse 2	63	174	16.4	54.2
Spillway	26	167	2.6	0.6
Total	*199*	*630*	*42.3*	*165.8*

As in past years, hazing activity temporarily moved some sea lions out of tailrace areas, but the animals typically returned and resumed foraging shortly after hazers left the area. Overall, actual active hazing was slightly more than last year, but occurred during less hours of being present.

Trapping and Removal

In 2013, personnel from ODFW and WDFW operated four traps in the Bonneville Dam tailrace area as they have for the past several years. These traps were used to capture sea lions for branding, application of acoustic and GPS transmitters, test application of Critter Cams®, and permanent removal of specific CSL from the population. Additional trapping occurs at Astoria, primarily for branding purposes. Four CSL that were on the list for removal were captured at Bonneville in 2013. Other captured CSL and SSL were given brands, and some were given an acoustic and/or GPS transmitter and released at Bonneville. Successful trapping events are summarized in Appendix C.

In 2013, a total of 15 different CSL were captured at Bonneville. Of those, 11 were given brands, three a GPS transmitter, two were relocated to Queens Zoo, New York (C08 and C023), and two were euthanized (C018 and C022). GPS tracking data will be presented by ODFW, WDFW and CRITFC in a separate report (Brown et al., 2013, in prep.).

In addition, 2 SSL were trapped in 2013 and fitted with Critter-Cam's and tracking devices by National Geographic staff to test remote detachment technology. One Critter-Cam was recovered off the coast of southern Washington and the other never found. Both left the Bonneville tailrace immediately after release and headed downstream toward the ocean. Little useful footage of relevance to the Bonneville studies was seen (Wright, ODFW, personal communication).

Impact of the Removal of Selected California Sea Lions

Although higher than last year, CSL salmonid predation was still lower than any other year since 2003 (figures 2 and 4, tables 9 and 10). Mean daily CSL abundance in 2013 was again lower than any year since 2002 and continues the downward trend that began after 2008 (Figure 12), although maximum daily CSL and individual CSL identified increased somewhat since last year. These results provide some evidence that the impact of the CSL removal program conducted since 2008 may be at least partially responsible for reducing the CSL abundance and predation on salmonids by CSL at Bonneville Dam. However, the unusual event of the influx of large numbers of new CSL males showing up at Bonneville Dam tailrace in 2010 and 2013, coupled with the virtual halting of removal actions in 2011, make further analysis of this program more difficult. It is also likely the reduction in predation on the early Chinook salmon runs (Figure 6) is due to the removal of many of the returning CSL that would arrive earlier each year waiting for the arrival of Chinook salmon. The increasing presence and salmon predation by SSL at Bonneville Dam could also continue to complicate the issue if current trends persist. Overall, there was similar clepto-parasitism (stealing prey by one individual from another) observed in 2013 and 2012, both being much less than the preceding four years (Table 11). Perhaps it was because there were fewer opportunities for that behavior as there were fewer CSL present and less CSL predation overall.

Table 9. Adjusted consumption estimates on adult (including jacks) salmonids by CSL and SSL at Bonneville Dam from January 1 through May 31, 2002 to 2013.

Year	California sea lions			Steller sea lions		
	Adjusted salmonid consumption estimates	Salmonid consumption per capita	% of run (Jan 1 – May 31)	Adjutsted salmonid consumption estimates	Salmonid consumption per capita	% of run (Jan 1 – May 31)
2002	1,010	33.7	0.4%	0	0.0	0.0 %
2003	2,329	22.4	1.1%	0	0.0	0.0 %
2004	3,516	35.1	1.9%	13	4.3	0.0 %
2005	2,904	35.9	3.5%	16	4.0	0.0 %
2006	3,428	47.6	3.2%	88	8.0	0.1 %
2007	4,492	63.3	4.8%	15	1.7	0.0 %
2008	4,901	59.9	3.2%	198	5.1	0.1 %
2009	4,505	83.4	2.4%	628	24.2	0.3 %
2010	5,481	61.6	2.0%	1,061	14.1	0.4 %
2011	2,713	50.2	1.2%	1,294	14.5	0.6%
2012	1,077	27.6	0.6%	1,305	17.9	0.8%
2013	1,510	27.0	1.2%	1,444	18.1	1.2%

Table 10. Maximum number of salmonids observed consumed by identified CSL at Bonneville Dam from January 1 through May 31, 2002 to 2013.

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	42.2%

* Began observation season late, didn't have opportunity to train observers on individual CSL identification.

Table 11. Summary of estimates of clepto-parasitism events observed at Bonneville Dam , 2002 to 2013. Most involve salmonids (e.g. we observed 490 Chinook, 20 steelhead, 4 sturgeon, and 16 unidentified prey stolen in 2010, all sturgeon being SSL from SSL events).

Year	CSL from CSL	CSL from SSL	SSL from SSL	SSL from CSL	Other	Total
2002	0	0	0	0	0	0
2003	14	0	0	0	0	14
2004	366	22	0	0	0	388
2005	22	0	0	22	6	50
2006	12	0	0	5	0	17
2007	33	0	0	4	0	37
2008	161	0	4	135	5	305
2009	152	4	7	324	6	492
2010	58	2	37	801	0	898
2011	2	0	12	279	0	293
2012	2	0	55	35	0	92
2013	1	0	19	67	0	87

It is possible that the increasing presence of SSL is a contributing factor in the decline of CSL abundance and predation over the past few years, although it is unclear whether SSL numbers are increasing due to the decline of CSL numbers, or if the increase in SSL numbers are responsible for "driving out" some of the CSL. Environmental factors, including river flows, turbidity and temperatures or even timing of the spring Chinook run may also be contributing factors to the decline of CSL abundance and predation. However, a simple look at the correlation of this data and CSL abundance and predation do not seem to indicate a strong relationship, and it should be pointed out that SSL abundance and predation trends have tended to be in the opposite direction than that for CSL.

RECOMMENDATIONS

1. In light of increasing SSL abundance and white sturgeon and salmonid consumption, the earlier and more protracted presence of SSL from October through May, and concurrent decrease in CSL presence and predation, we strongly suggest a continuation of this monitoring program at this level for four more years. The states again have received a permit to remove specific CSL from the Bonneville population. The full impact of removal of specific individual CSL cannot be fully measured until the subsequent year's monitoring is completed. However, long term monitoring efforts need to be discussed among the action agencies to determine the usefulness, resolution, and costs of the information obtained.
2. The Corps should continue to coordinate with agency partners (such as ODFW, Portland State University and CRITFC) performing observations in the area downstream of our study area,.
3. SLEDs and FOG barriers have proved effective and should continue to be used to prevent sea lions from entering the fishways of Bonneville Dam. If presence of sea lions in the fall becomes a regular occurrence, the Corps and regional fish passage agencies should consider installing these barriers in the fall, or leaving them in place for the entire fish passage season.
4. The Corps should continue to assist in the pursuit and evaluation of potential non-lethal deterrent technologies as part of a long-term strategy to reduce pinniped predation on adult salmonids, sturgeon, and lamprey in the Bonneville Dam tailrace.
5. ODFW/WDFW should strongly consider adding additional traps and/or additional methods for removal of more individual CSL each season (e.g. 30, not 10-15).
6. Use of an optical camera (e.g.Critter-Cam©) affixed to multi-year CSL and SSL early in the season would allow biologists to get a better understanding of how and where the sea lions are taking prey, and possibly if there is significant underwater consumption going on undetected by surface observations.

ACKNOWLEDGEMENTS

We would like to thank all who continue to help us provide the most accurate information on pinniped predation at Bonneville Lock and Dam. The Columbia River Inter-Tribal Fish Commission conducted the vast majority of the boat-based hazing program, while the USDA Wildlife Services continued to conduct the dam-based hazing program. Special thanks to Robin Brown (ODFW), Steve Jeffries (WDFW), Matt Tennis (PSMFC), and Bryan Wright (ODFW) for their advice, input, and cooperation. Bernard Klatte and Sean Tackley (USACE) helped with study objectives, funding, and program support. The Bonneville Lock and Dam rigging crew should be commended for successfully deploying and removing SLEDs.

A very big thank you goes to all the observers who collected valuable data for us this year. Interns from the Student Conservation Association (SCA) did a great job with observations and assisting with data management. Inga Aprans, Claire Brown, Chelsi Burger, Justin Emmons, Karl Seitz, and Kris Warner endured the extreme cold, snow, and rainy weather conditions this past winter and spring and performed admirably. Mike Jonas and Patricia Madson of the Fisheries Field Unit helped with observations in the fall of 2012 in addition to their other duties and their efforts helped increase the sample size for our fall work.

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Appendix A. Table of progressive estimates of pinniped predation on salmonids (also broken out by pinniped species) at Bonneville Dam, 2002-2013, adjusted for unidentified fish prey caught, and nighttime predation.

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%

ADJUSTED FOR UNIDENTIFIED FISH

			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	3,401	3.14%	3,312	3.05%	85	0.08%
2007	4,433	88,474	4,355	4.69%	4,340	4.68%	15	0.02%
2008	5,131	147,558	4,927	3.23%	4,735	3.11%	192	0.13%
2009	3,455	186,056	4,960	2.60%	4,353	2.28%	607	0.32%
2010	3,609	267,167	6,321	2.31%	5,296	1.94%	1,025	0.37%
2011	3,315	223,380	3,971	1.75%	2,689	1.18%	1,282	0.56%
2012	3,404	171,665	2,360	1.36%	1,067	0.61%	1,293	0.74%
2013	3,247	120,619	2,928	2.37%	1,497	1.21%	1,431	1.16%

ADJUSTED FOR NIGHT HOURS NOT OBSERVED (AN ADDITIONAL 3.5% ADDED 2006-2010, 0.9% 2011-2013)

			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	3,520	3.24%	3,428	3.16%	88	0.08%
2007	4,433	88,474	4,507	4.85%	4,492	4.83%	15	0.02%
2008	5,131	147,558	5,099	3.34%	4,901	3.21%	198	0.13%
2009	3,455	186,056	5,134	2.69%	4,505	2.36%	628	0.33%
2010	3,609	267,167	6,542	2.39%	5,481	2.00%	1,061	0.39%
2011	3,315	223,380	4,007	1.76%	2,713	1.19%	1,294	0.57%
2012	3,404	171,665	2,382	1.37%	1,077	0.62%	1,305	0.75%
2013	3,247	120,619	2,954	2.39%	1,510	1.22%	1,444	1.17%

Appendix B. Maps (Figures B1-B3) of Bonneville Lock and Dam and vicinity, with predations zones shown.

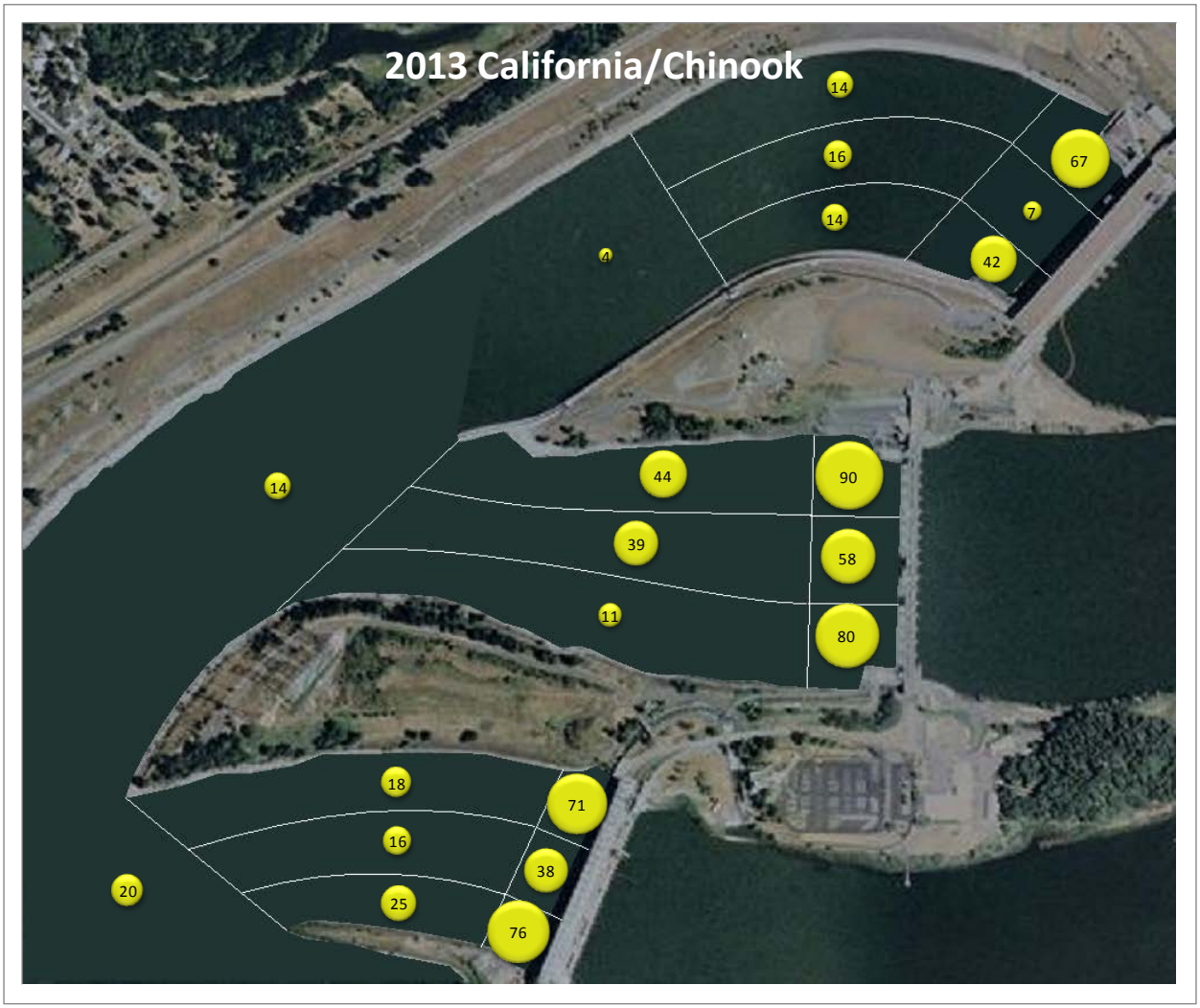

Figure B1. Frequency distribution by location of Chinook salmon caught by CSL at Bonneville Dam, 2013.

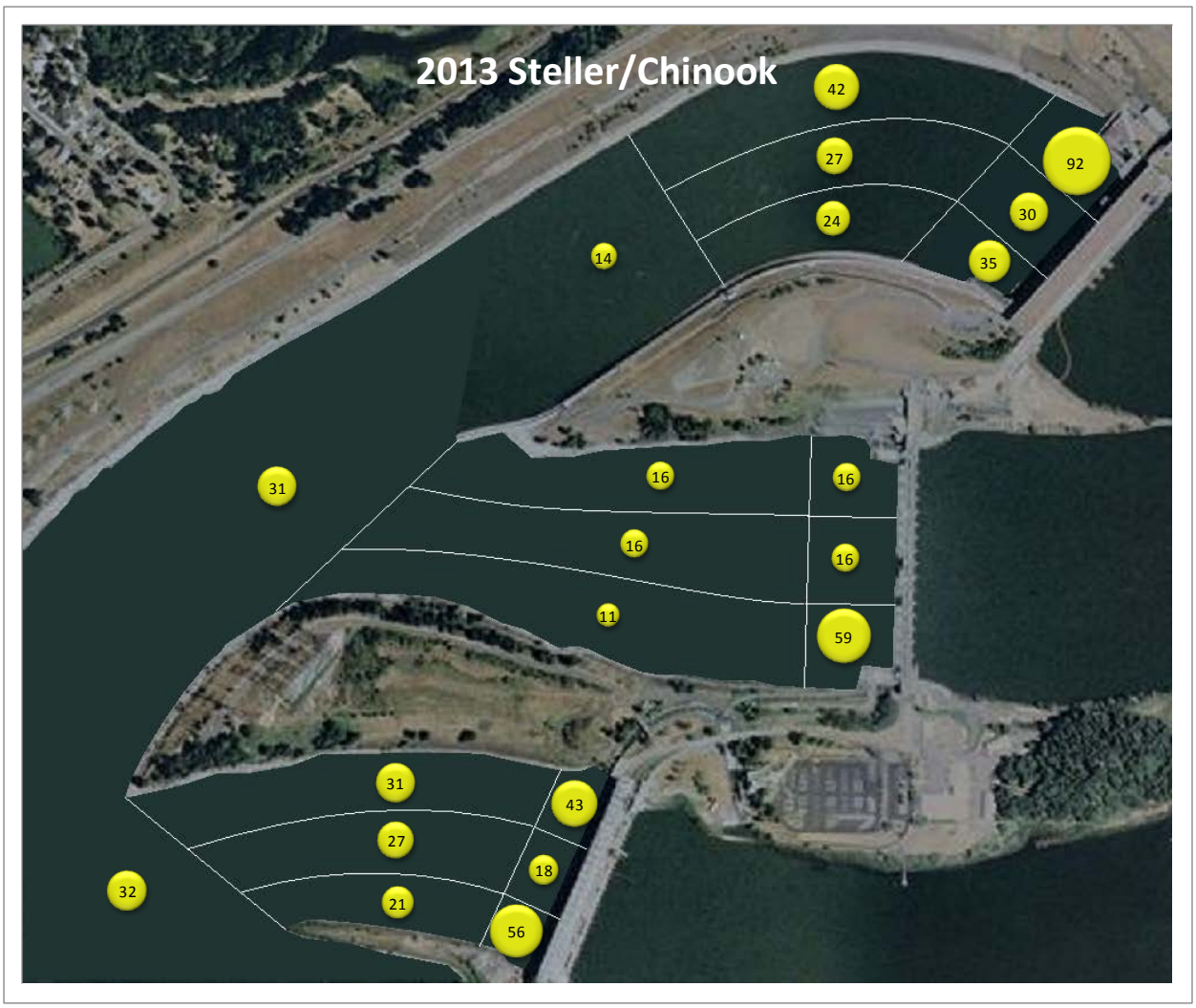

Figure B2. Frequency distribution by location of Chinook salmon caught by SSL at Bonneville Dam, 2013.

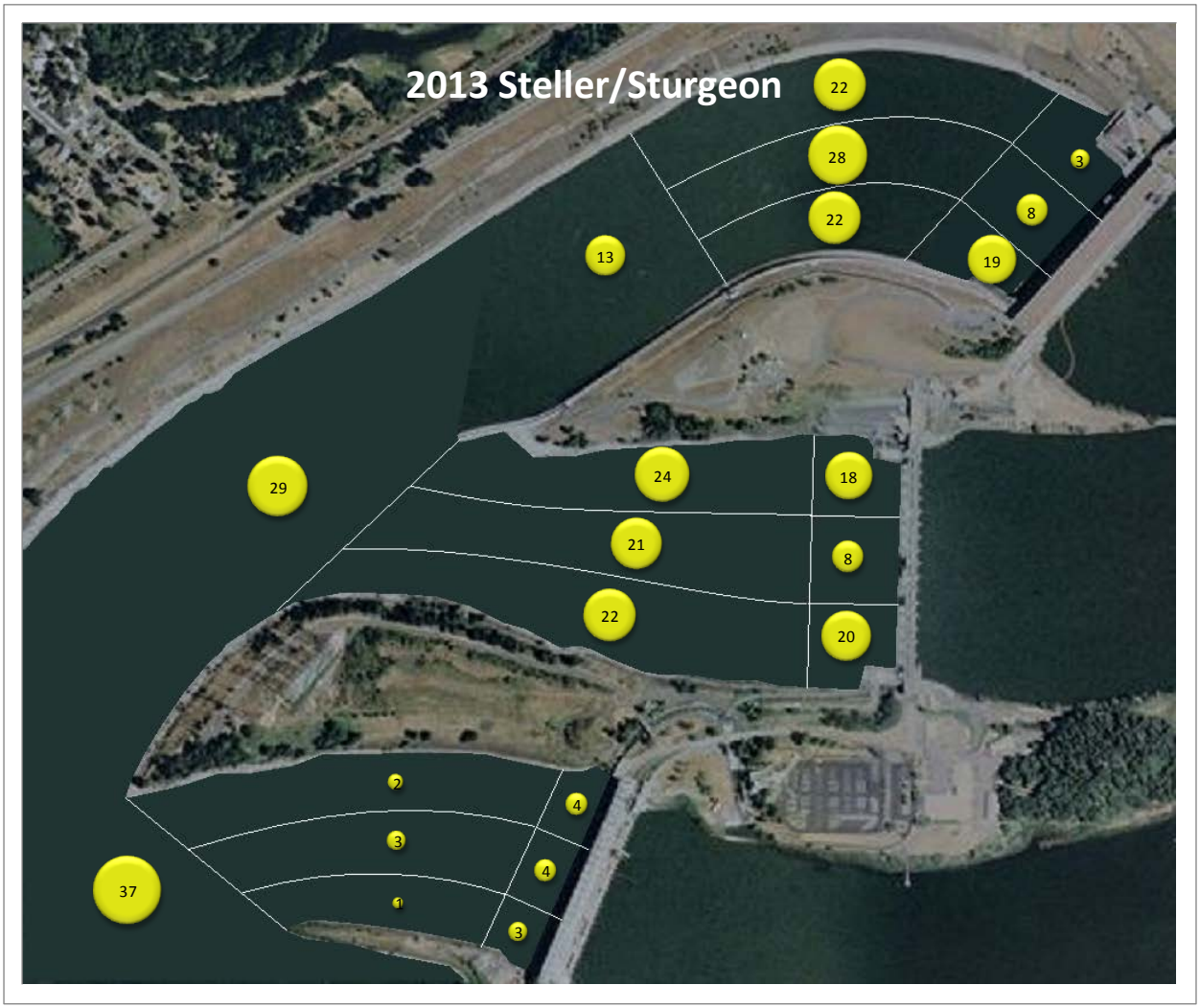

Figure B3. Frequency distribution by location of white sturgeon caught by SSL at Bonneville Dam, 2013.

Appendix C. List of CSL trapped at Bonneville Dam in 2013. (Yellow highlight denotes animal removed from population known to visit Bonneville Dam)

Species	*Sea lion ID*	*Capture date*	*On removal list?*	*Action*	*Additional information*
CSL	C022/B368	4/16/2013	Yes	Euthanized	
CSL	C025	4/23/2013		Released	Branded, GPS, and released
CSL	C026	4/23/2013		Released	Branded, GPS, and released
CSL	C027	4/30/2013		Released	Branded, GPS, and released
CSL	C028/B379	4/30/2013		Released	Branded and released
CSL	C029/B380	4/30/2013		Released	Branded and released
CSL	C030/B381	4/30/2013		Released	Branded and released
CSL	C031/B382	4/30/2013		Released	Branded and released
CSL	C032/B383	4/30/2013		Released	Branded and released
CSL	C033	4/30/2013		Released	Branded and released
CSL	C08/B340	4/30/2013	Yes	Relocated	Relocated to Queens Zoo, NY
CSL	C018	4/30/2013	Yes	Euthanized	
CSL	C023	4/30/2013	Yes	Relocated	Relocated to Queens Zoo, NY
CSL	C034	5/7/2013		Released	Branded and released
CSL	C035/B371	5/7/2013		Released	Branded and released

Note – Some animals have both a “C” or “U” brand and a “B” code as these individuals were originally identified through documentation of natural physical features and were subsequently branded either at Bonneville Dam or Astoria. Additional animals were trapped and released without any handling.

Appendix D. Adjusted estimate of prey taken by SSL and CSL between October 1 and December 31 at Bonneville Dam tailrace, 2011 and 2012.

FALL-WINTER STELLER PREDATION		
	2011	2012
Chinook	317	95
Steelhead	187	165
Coho	20	85
Chum	4	6
Total Salmonids	527	351
Sturgeon	828	456
Lamprey	8	17
Shad	19	12
Smolt	3	0
Carp	10	8
Sucker	0	2
Bass	0	2
Pikeminnow	0	2
Other	4	19

FALL-WINTER CALIFORNIA PREDATION		
	2011	2012
Chinook	0	10
Steelhead	0	19
Coho	0	9
Chum	0	0
Total Salmonids	0	38
Sturgeon	0	0
Lamprey	0	0
Shad	0	0
Smolt	0	0
Carp	0	0
Sucker	0	0
Bass	0	0
Pikeminnow	0	0
Other	0	0