ANNUAL REPORT:
PINNIPED MONITORING AT WILLAMETTE FALLS, 2024-2025

October 20, 2025

Bald eagle attempting to take salmonid from California sea lion below Willamette Falls, 3/7/25
(photo credit: C. Owen, ODFW)

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INTRODUCTION

The Marine Mammal Protection Act (MMPA) of 1972 provides federal protection to all marine mammal species in U.S. waters. As a result of this legislation, the U.S. stock of California sea lions (*Zalophus californianus*) and the eastern stock of Steller sea lions (*Eumetopias jubatus*) have increased to the point that they are now both likely within their Optimum Sustainable Population ranges (Caretta et al. 2024; Young et al. 2024). Over this same period, many salmon and steelhead (*Oncorhynchus* spp.) populations in the Pacific Northwest experienced significant declines in abundance and were subsequently listed as threatened or endangered under the Endangered Species Act (ESA). While pinniped predation was not the ultimate cause of these declines, in areas where salmonid abundance is low and pinniped numbers are high, increased predation can result in significant negative impacts on the survival and recovery of individual salmonid populations.

One such area of relatively low salmonid and high pinniped abundance is Willamette Falls on the Willamette River, approximately 206 km (128 mi) upriver from the Pacific Ocean. While the first known record of a California sea lion at Willamette Falls was of a single animal in the 1950s (Beach et al. 1985), it wasn't until the mid-1990s that California sea lions were frequently seen foraging on winter steelhead and spring Chinook salmon attempting to pass the Falls (Oregon Department of Fish and Wildlife [ODFW], unpublished data). Concerned that Willamette Falls would become another "Ballard Locks"—a site in Washington where California sea lions effectively extirpated a run of steelhead (*O. mykiss*) (Fraker and Mate 1999)—ODFW began a predation monitoring program at Willamette Falls in 1995, as well as a California sea lion marking program at Astoria in 1997 to identify and track California sea lions in the Columbia River Basin (Brown et al. 2020).

Intermittent predation monitoring at the Falls by ODFW occurred from 1995–2003, after which the agency's limited resources were shifted to Bonneville Dam on the Columbia River, where California sea lion predation on salmonids also began increasing (e.g., Keefer et al. 2012; Braun et al. 2025). Attention soon returned to Willamette Falls, however, as winter steelhead passage decreased and sea lion activity increased. This led ODFW to conduct non-lethal hazing at Willamette Falls in 2010, 2011, and 2013 in an attempt to deter sea lions from consuming threatened winter steelhead near the fish ladder entrances. However, as has been seen elsewhere (e.g., see review in Scordino 2010), non-lethal deterrents had only limited and short-term effects, as pinnipeds eventually adapted to them.

Hazing was discontinued after 2013 to shift limited resources to a rigorous monitoring effort. That effort showed that California sea lion abundance had increased since the late 1990s and early 2000s, and that California sea lion predation had become particularly acute for threatened winter steelhead populations. In addition, Steller sea lions also began showing notable increases in abundance and residency starting in 2017. Based on the results of this monitoring, the state of Oregon requested lethal removal authority for California sea lions under Section 120 of the MMPA, which was subsequently granted on November 14, 2018 (NMFS 2018), and later expanded to include Steller sea lions on August 25, 2020 (NMFS 2020). This report summarizes the 12th consecutive year of pinniped monitoring at Willamette Falls and partially fulfills reporting requirements under our MMPA management authorization.

METHODS

Study area

The study area extended from Willamette Falls on the Willamette River downstream to approximately the mouth of the Clackamas River, although formal observations were only conducted in the immediate vicinity of the Falls (sites 1–6; Figures 1–2). The Falls are located approximately 42 km (26 mi) upriver from the confluence with the Columbia River and approximately 206 km (128 mi) from the ocean. It is the second-largest waterfall in the United States by volume, after Niagara Falls (ECONorthwest 2014).

Pinniped species accounts

Three pinniped species have been known to occur at Willamette Falls: California sea lions, Steller sea lions, and Pacific harbor seals (*Phoca vitulina*).

<u>California sea lions</u>—California sea lions occur seasonally at Willamette Falls, primarily during the spring, with recent daily counts typically in the single digits. They are predominantly seasonal migrants to the Pacific Northwest, mostly sub-adult and adult males, arriving in late July and departing by late June as they move to and from breeding grounds in southern California and Mexico (Wright et al. 2010; Elorriaga-Verplancken et al. 2014; Brown et al. 2020). California sea lions in Oregon belong to the U.S. stock, most recently estimated in 2014 at approximately 257,606 animals (Laake et al. 2018, Carretta et al. 2024). This stock is not listed as endangered or threatened under the ESA, nor as depleted or strategic under the MMPA (Carretta et al. 2024).

<u>Steller sea lions</u>—Steller sea lions occur seasonally at Willamette Falls, primarily during the winter and spring, with recent daily counts typically in the single digits. Unlike California sea lions, Steller sea lions have a large breeding population in Oregon. They belong to the eastern Distinct Population Segment (DPS), most recently estimated in 2022 at approximately 31,289 pups (95% credible interval of 21,264–44,298) and 66,150 non-pups (95% credible interval of 49,688–84,914) ashore (Young et al. 2024). The stock is not listed as "endangered" or "threatened" under the ESA, nor as "depleted" or "strategic" under the MMPA (Young et al. 2024).

<u>Harbor seals</u>—Harbor seals, while common and abundant throughout coastal Oregon, are rare and inconspicuous visitors to upriver sites such as Willamette Falls. Harbor seals in Oregon belong to the Oregon/Washington coastal stock. The most recent (1999) estimate of the total stock was 24,732 animals (Carretta et al. 2024). However, since this estimate is out of date, the current population abundance and trend for this stock are unknown. The stock is not listed as "endangered" or "threatened" under the ESA, nor as "depleted" or "strategic" under the MMPA (Carretta et al. 2024).

Fish species accounts

Fish species primarily preyed upon by pinnipeds at Willamette Falls include winter and summer steelhead, marked (hatchery) and unmarked (wild) spring Chinook salmon (*O. tshawytscha*), Pacific lamprey (*Entosphenus tridentatus*), and white sturgeon (*Acipenser transmontanus*). All of these species are of conservation or management concern, and two—winter steelhead and wild spring Chinook salmon—are listed as "threatened" under the ESA.

<u>Winter and summer steelhead</u>—All naturally produced winter-run steelhead populations in the Willamette River and its tributaries above Willamette Falls to the Calapooia River are part of the ESA-listed Upper Willamette River (UWR) steelhead DPS (National Marine Fisheries Service [NMFS] 2024). These fish pass Willamette Falls from November through May, partially overlapping with introduced, marked summer steelhead that pass the Falls from March through October. While there is no directed fishery for winter-run steelhead in the upper Willamette River, hatchery-origin summer steelhead are not ESA-listed and support popular recreational fisheries in the Santiam, McKenzie, and Middle Willamette subbasins.

<u>Spring Chinook salmon</u>—All naturally produced populations of spring Chinook salmon in the Clackamas River and in the Willamette Basin upstream of Willamette Falls are part of the ESA-listed UWR Chinook salmon Evolutionary Significant Unit (ESU) (NMFS 2024). These fish pass Willamette Falls from April to August and co-occur with a more abundant run of hatchery-origin spring Chinook salmon. Hatchery-produced spring Chinook salmon support economically and culturally important fisheries in the lower Columbia and Willamette rivers, part of which takes place in the study area below Willamette Falls.

Migrating salmonids pass Willamette Falls by entering one of four entrances to three fishways through the Falls. Video cameras and timelapse video recorders are used to record fish passage, which is later reviewed to produce passage counts. Salmonid species are partitioned by run (e.g., winter/summer steelhead, unmarked/marked spring Chinook salmon) based on passage date and the presence or absence of a hatchery fin clip.

Pinniped counts

We estimated pinniped abundance in the study area based on a combination of direct observations as well as imagery from automated time-lapse cameras located at potential haulout sites throughout the area. Counts at Willamette Falls (i.e., sites 1–6; Figure 1) were conducted during weekday, daytime observation shifts, whereas camera counts were based on hourly images taken 24 hours a day, 7 days a week. Both types of counts were then added together when appropriate to obtain a maximum count for that calendar day, which was then used as an index of minimum abundance. Alternatively, if the tally of individual animals observed over a given calendar day was greater than the maximum count, that number was used for that day. For the fall and early winter period before formal observations began, we only used camera counts and anecdotal observations to obtain daily counts. As a result, fall and early winter counts may be biased low compared to the formal January–May study period. The maximum daily count for a given week was used as an index of the minimum number of individuals present in the study area for that week. These counts are indices of abundance and likely underestimate the true abundance for any given time period due to imperfect detectability of individual animals.

In addition to conducting pinniped counts immediately below Willamette Falls, we also conducted periodic boat-based surveys of the Willamette River to determine how much pinniped activity occurred below the formal study area. Surveys were typically conducted in a single 24-ft closed-cabin boat traveling downstream at approximately 5 knots with a minimum of two staff. Surveys began in Oregon City below Willamette Falls and proceeded downriver, typically to the confluence with the Columbia River (42 km; 26 mi). Staff recorded the number, behavior, and location of each species of pinniped observed, which were also photographed when possible. Observations were generally only recorded while traveling downriver, since the upriver return trip was made at higher speeds.

Pinniped predation estimation

While pinnipeds can consume small prey underwater, they usually must surface to manipulate and consume larger prey, such as an adult salmonid (Roffe and Mate 1984). We utilized this aspect of their foraging behavior (i.e., surface-feeding), in conjunction with statistical sampling methods (e.g., Lohr 1999; Hankin et al. 2019), to estimate the total number of adult salmonids consumed by sea lions over a spatio-temporal sampling frame. From 2014–2020, we estimated total surface predation of adult salmonids based on a (pseudo) probability sample generated from a three-stage cluster sampling design, with repeated systematic samples at each stage (e.g., Wright et al. 2020). In 2021, to mitigate COVID-19 risks, we experimented with a new sampling design (Halton iterative partitioning; Robertson et al. 2018; Hankin et al. 2020), which required fewer full-time staff. After 2021, we resumed using the three-stage cluster sampling design.

The variable of interest was the initiation of a surface-feeding event, whereby a sea lion was observed to surface and begin prey consumption within a given spatio-temporal observation unit. Since prey handling and consumption for some prey species, such as large sturgeon, can last over an hour and drift over a kilometer downstream, we only formally recorded events that included observations of the initial surfacing immediately after prey capture; all other events were treated as anecdotal. We included both predation on free-swimming fish and depredation of hooked fish in the recreational fishery (collectively referred to as "predation" hereafter unless specifically noted). We assumed that the probability of detecting an event, given that it occurred, was one. Surface-feeding observations were conducted from shore by visually scanning a given area with unaided vision and/or binoculars. For each event, trained observers recorded the time, site, sea lion species, prey species, and whether the fish may have been taken from an angler. If prey appeared to escape without mortal wounds, the event was noted but not included in the tally used for estimation.

Observers followed a schedule of when and where to observe based on a probability sample generated from a three-stage cluster sampling design, with repeated systematic samples at each stage (see Figures 1 and 2, and Appendix A for descriptions of the design; see Lohr 1999 for background on sampling; see Wright et al. 2007 for implementation of this design elsewhere). The first stage, or primary sampling units (PSUs), were "days of the week" (i.e., Sunday, Monday, etc.). The second stage, or secondary sampling units (SSUs), were "site-shifts" within a day of the week (e.g., 0700–1530 at specified site[s]). The third stage, or tertiary sampling units (TSUs), were 30-minute observation bouts within a site-shift (i.e., three out of every four 30-min periods at a given site). Due to constraints imposed by work schedules (e.g., lunch breaks, days off), some deviations from a truly randomized design were unavoidable. However, since there is no reason to believe that sea lion foraging behavior varies systematically with observer breaks or weekends/holidays, imposing some restrictions on randomization is unlikely to introduce bias into estimation.

The spatial component of the sampling frame consisted of six sites in a single stratum (Figure 1). This is identical to the 2016–2024 study years, but in contrast to 2014–2015, which had sites spread over two strata (Figure 2). Sites 1–6 were each approximately 0.9 ha in area and occurred immediately below the Falls, where predation activity is typically greatest. The temporal component of the sampling frame consisted of a subset of daylight hours, ranging from 0800–1630 PST (8.5 hours) in January to 0600–1900 PDT (13 hours) in May (Figure 2).

In 2025, there were 1,460 half-hour observation units (i.e., elements) in the sample out of a sampling frame of 21,936 units, resulting in an element-wise sampling fraction of 6.7%; the cluster-wise sampling fraction was also 6.7% (120 clusters out of 1,792; see Appendix A). The sampling weight was 14.93, meaning that each observed predation event represented itself and 13.93 additional unobserved events. Based on previous pilot testing of the design against simulated data, it was anticipated that the total salmonid predation estimate would have a coefficient of variation (CV) of 10% or less (estimates with CVs over 33% are generally considered unreliable). Missing elements (e.g., due to holidays, unsafe weather conditions, missed assignments, etc.) were assumed to be missing completely at random and were imputed as zeros, which likely contributed to a small negative bias in the predation estimates.

Observed salmonid predation events were assigned to a run (i.e., summer/winter steelhead, unmarked/marked spring Chinook salmon) based on a combination of field observations, fishway window counts, and Monte Carlo methods. We did this using a two-step approach. In the first step, we either used observer identification of salmonids to species (if available), or we treated all salmonids as unknown, regardless of whether they may have been identified in the field to species. In the second step, we assumed prey consumption was proportional to the run composition derived from window counts, which we computed by pooling counts over 1, 7, or 14 days after an observed event (see Keefer et al. 2004).

As an example, if a steelhead was killed on Monday and the window count composition for steelhead on Tuesday was 50% winter steelhead and 50% summer steelhead, the observed kill would be assigned to a run based on a metaphorical coin toss. For the case of "unknown" salmonids, if a salmonid was killed on Monday and the window count composition on Tuesday was 90% winter steelhead, 5% summer steelhead, 4% marked spring Chinook salmon, and 1% unmarked spring Chinook salmon, the observed kill would be assigned to a run based on a metaphorical toss of a 100-sided die, where 90 sides were winter steelhead, 5 were summer steelhead, etc.

Each of the six models was run for 1,000 iterations, and means were computed for run-specific total predation and associated measures of uncertainty. Predation relative to potential passage was calculated as the estimated predation total divided by the sum of passage and estimated predation. Prior to 2024, we only estimated run-specific predation for California sea lions due to the relatively small number of salmonids taken by Steller sea lions. However, this number has been increasing in recent years, and in 2024 there were sufficiently large numbers of salmonids consumed by Steller sea lions to meaningfully partition take by run. For completeness, we estimated annual run-specific take by Steller sea lions for the entire study period from 2014–2025.

Additional activities

The predation monitoring design in 2025 was implemented using a single full-time staff member, who was assisted when needed by additional staff. Due to the nature of random sampling, as well as limits on how long one can sustain intense concentration, not all hours of every day were devoted to conducting sample-based observations. Any time not needed for sample-based observations was used for administrative tasks, conducting anecdotal predation observations, haul-out counts, and photographing pinnipeds to identify individual animals.

RESULTS

River conditions

River height and temperature near Willamette Falls are summarized in Figure 3.

Salmonid fishway passage

Salmonid passage over Willamette Falls by run is summarized in Figure 4. Passage of both winter and summer steelhead declined following strong runs in 2024, whereas passage of marked and unmarked spring Chinook salmon was approximately average for the study period.

Pinniped counts

Pinniped counts based on automated cameras and incidental observations by staff began in July 2024, before sea lions migrated into the study area, and continued through June 2025, when sea lions had migrated out of the study area. Counts based on formal observations at Willamette Falls began the second week of January 2025 and continued through mid-June 2025. Boat-based river surveys began in September 2024 and continued through May 2025.

<u>California sea lions</u>—The first documented California sea lion sighting in the study area was on January 24, 2025, but that animal was only observed for one day (Figure 5). The spring cohort did not begin arriving until March, when numbers increased from one individual to a peak of four in late April and early May. However, since these animals were unmarked, the actual number present during the study likely exceeded the daily maximum observed. Nevertheless, this year marked the lowest one-day maximum count for California sea lions since the current monitoring program began (Figure 6). The last California sea lion was observed on June 13, approximately two weeks later than most years. The relative abundance and timing of California sea lions observed during the boat surveys were similar to that observed at the Falls (Figure 7).

Steller sea lions—The first documented Steller sea lion sighting was on January 13, 2025, although they were likely present before the formal observation period began (Figure 5). At least three individuals were seen intermittently at the Falls through mid-March, followed by a gap until mid-April, when a single animal was observed through May 9. However, since these animals were unmarked, the actual number present during the study likely exceeded the daily maximum observed. This year tied the second-lowest maximum daily count for Steller sea lions since the current monitoring program began (Figure 6). Boat surveys in the lower river, however, documented many more Steller sea lions for a longer period of time than at the Falls, with as many as 14 seen in early February (Figure 7).

Predation

California sea lions—The estimated number of salmonids consumed by California sea lions over the six-site, 1,828-hour sampling frame was 627 fish (95% confidence interval: 528–727) (Table 1). Partitioning salmonids to run based on Monte Carlo modeling, we estimated that California sea lions consumed 72 winter steelhead (1.5% of potential passage), 86 summer steelhead (≤1.7% of potential passage), 78 unmarked spring Chinook salmon (1.4% of potential passage), and 391 marked spring Chinook salmon (1.5% of potential passage) (Table 2, Figures 8–9).

Steller sea lions—The estimated number of salmonids consumed by Steller sea lions over the six-site, 1,828-hour sampling frame was 45 fish (95% confidence interval: 3–106) (Table 1). Partitioning salmonids to run based on Monte Carlo modeling, we estimated that Steller sea lions consumed 1 winter steelhead (<0.1% of potential passage), 3 summer steelhead (≤0.1% of potential passage), 9 unmarked spring Chinook salmon (0.2% of potential passage), and 31 marked spring Chinook salmon (0.1% of potential passage) (Table 3, Figures 8–9).

DISCUSSION

The predation estimates presented in this report are based solely on probability samples and do not include anecdotal observations. The 95% confidence intervals reflect the sampling error in the estimates, which arises from taking a sample rather than a census of the population. A different sample would have produced a different estimate and confidence interval, but 95 times out of 100, the procedure will correctly capture the true population total within the interval. Non-sampling errors, however, are often a greater source of uncertainty than sampling errors. In this study, the non-sampling error of greatest concern is likely undercoverage (see Figure 2).

As in previous years, spatial and temporal undercoverage in our sampling frame likely resulted in our estimates of predation being biased low. Spatial undercoverage occurred because we only sampled the "Falls" strata, whereas we know predation occurs in the river and, in some years, the nearby Clackamas River. Temporal undercoverage also occurred because, as in prior years, some sea lions likely foraged outside of our daily sampling times (e.g., December; before sunrise and after 7 p.m.).

Despite potential undercoverage issues, predation estimates (Figures 7–8) and sea lion counts (Figure 6) continue to show a sustained decrease since management began in the Willamette

River under Section 120 of the MMPA. Salmonids in the Willamette River have likely also benefited from sea lion removals at Bonneville Dam on the Columbia River, as some sea lions have been known to forage at both sites. Although some new animals continue to discover the Falls each year, their numbers and associated predation remain far below pre-management peaks. Continued success in reducing predation at Willamette Falls, however, will likely depend on adapting management strategies to changes in sea lion haulout behavior.

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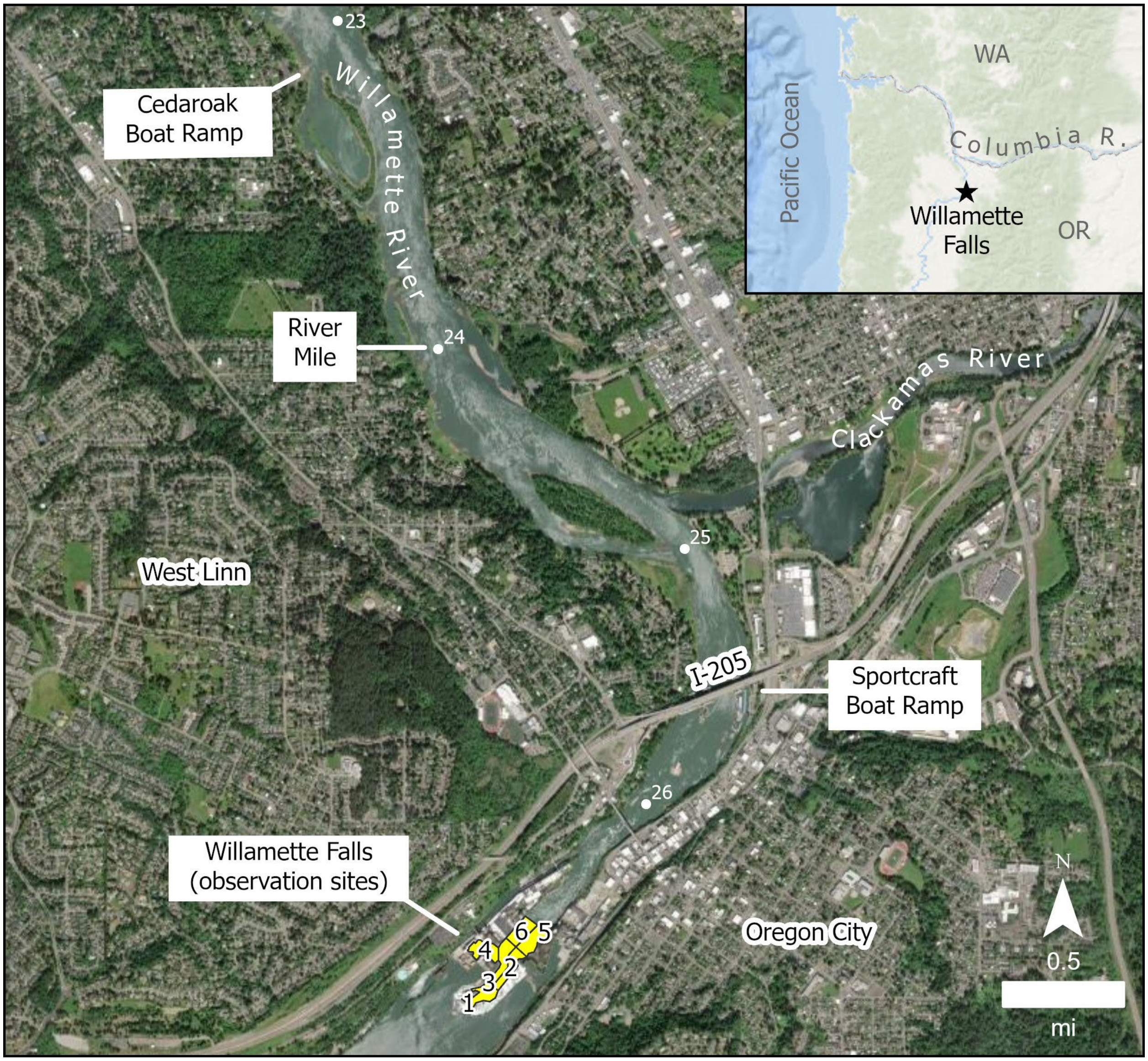


Figure 1. Map of the general study area showing key features, including formal observation sites at Willamette Falls (1–6 in yellow), boat ramps, and river mile markers.

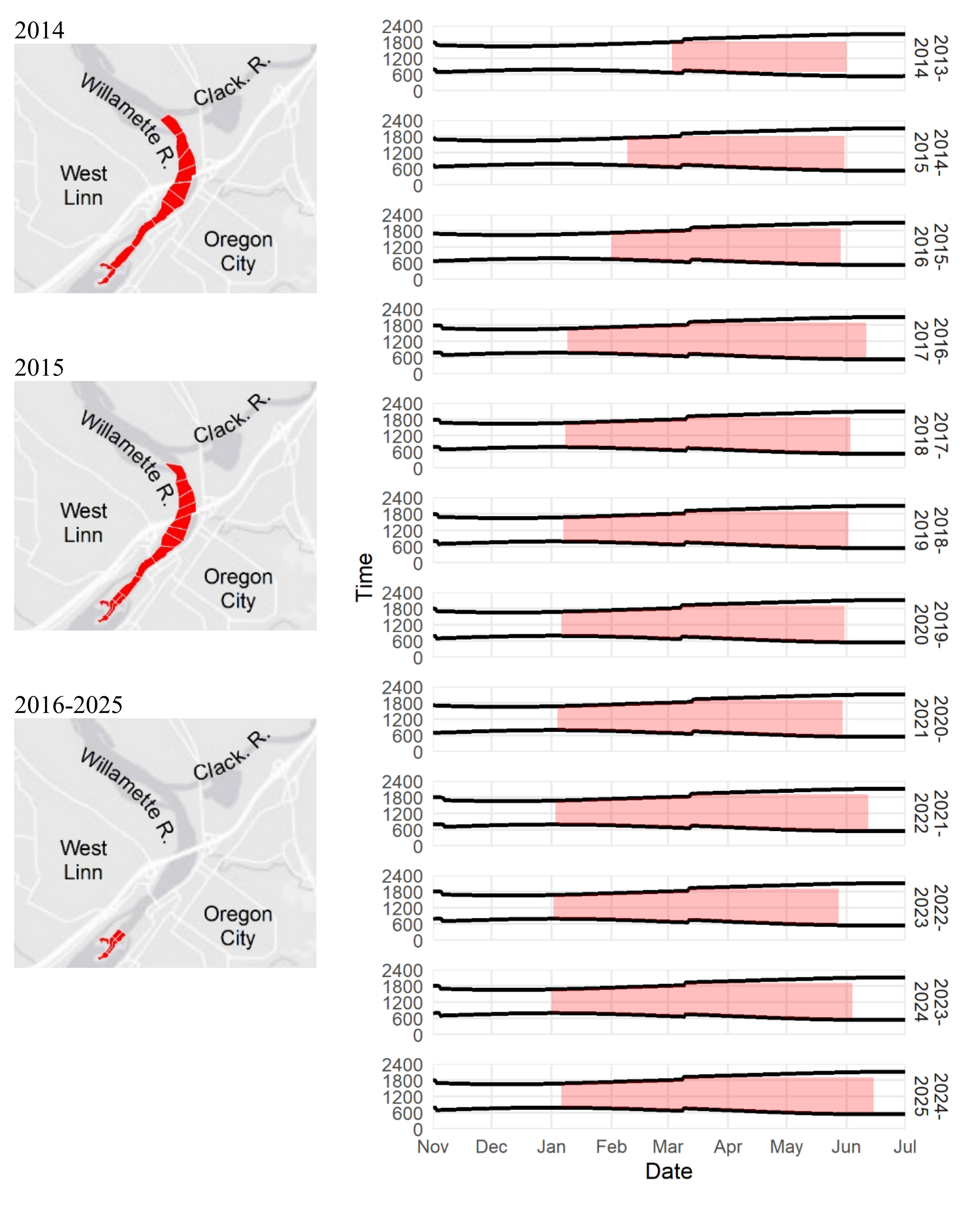


Figure 2. Illustration of the spatial (left) and temporal (right) coverage of the sampling frame by season. Red-shaded areas depict the time and area included in the sampling frame; dark black lines on the graph at right indicate sunrise and sunset, adjusted for daylight saving time.

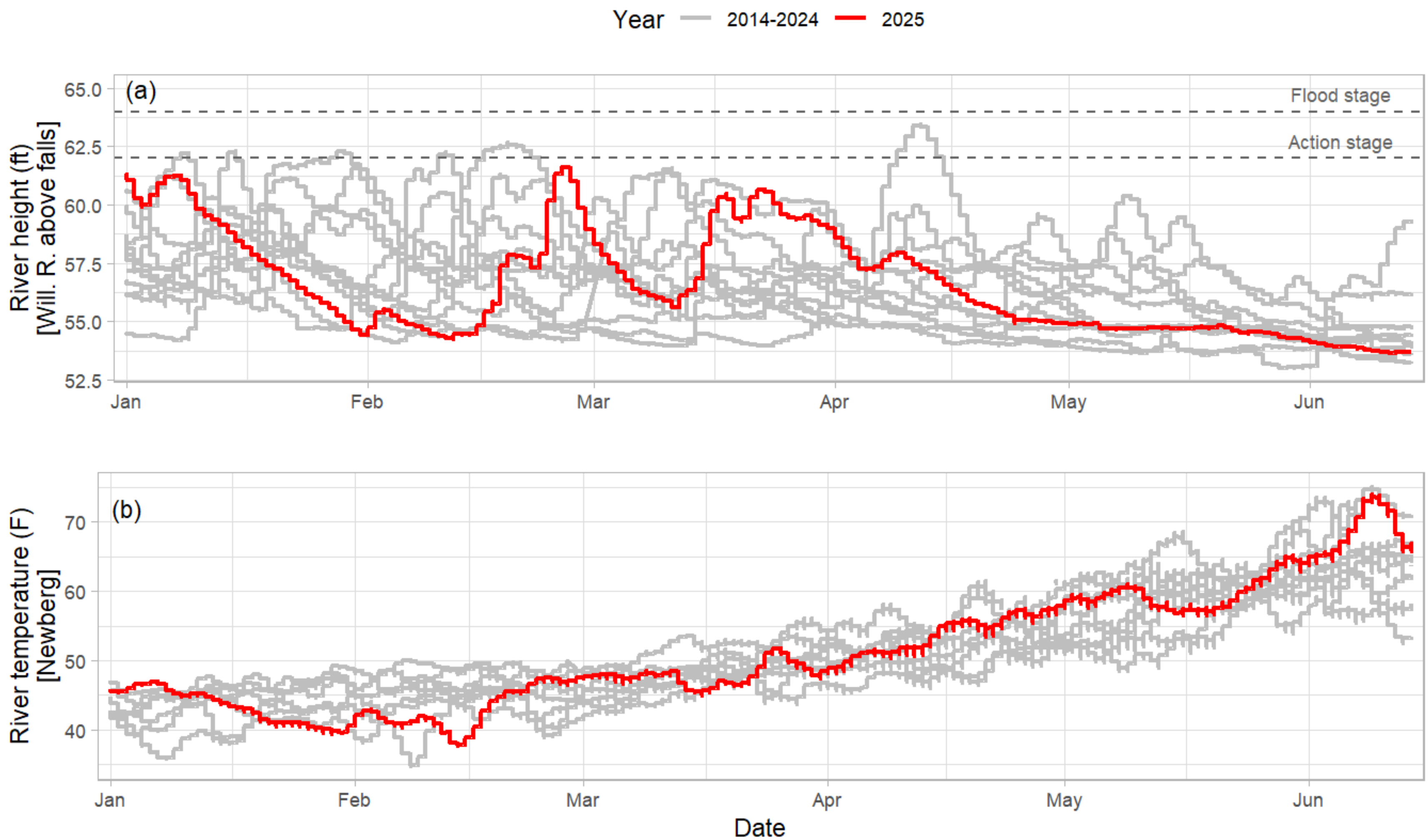


Figure 3. Annual variation in (a) water height and (b) temperature of the Willamette River, based on gauges located upstream of Willamette Falls.

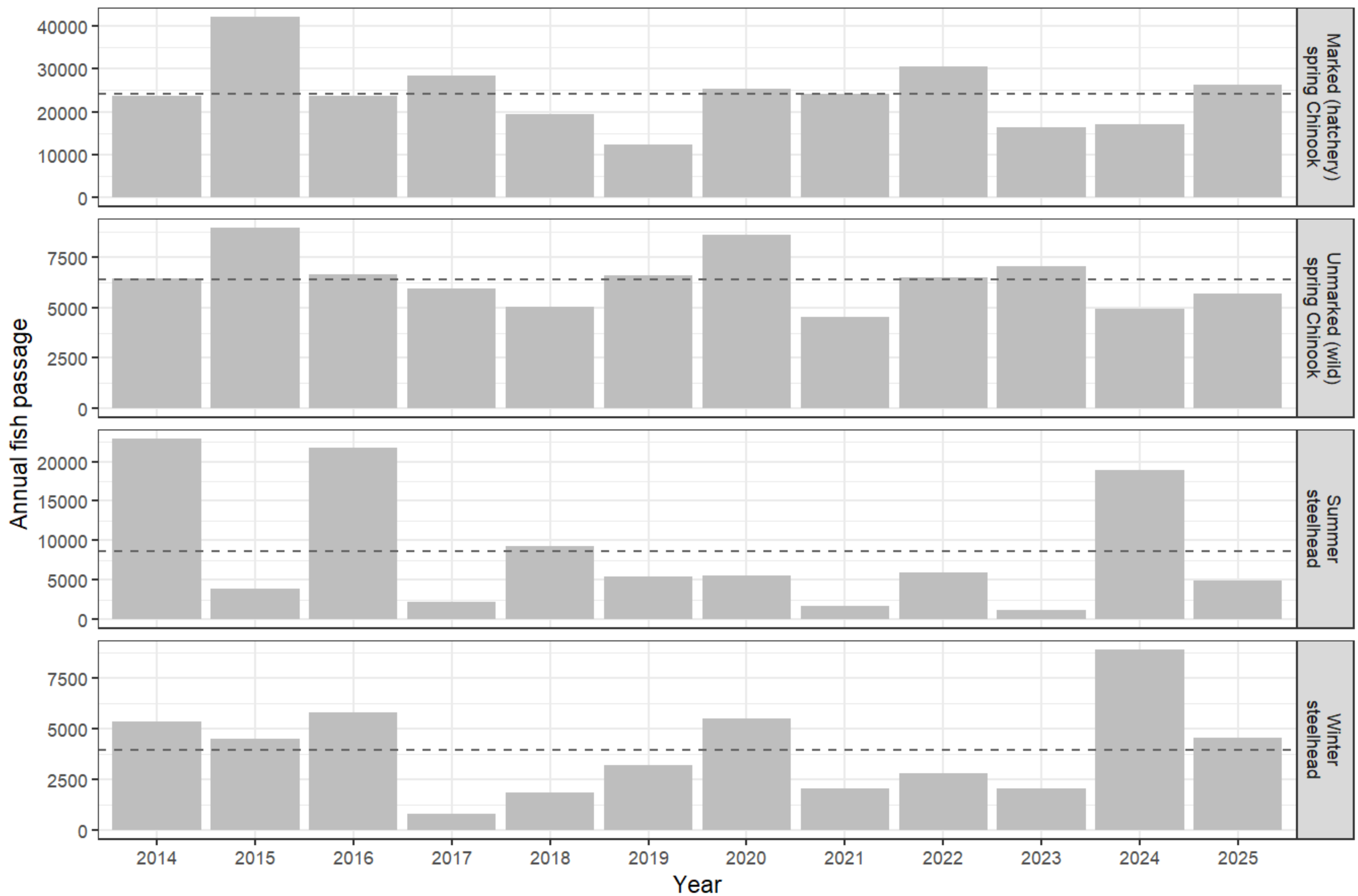


Figure 4. Annual fish passage at Willamette Falls by run and year; the average over the study period is denoted by a dashed line. Note that the y-axis scale varies by run, and the 2025 summer steelhead passage is only through 9/7/25.

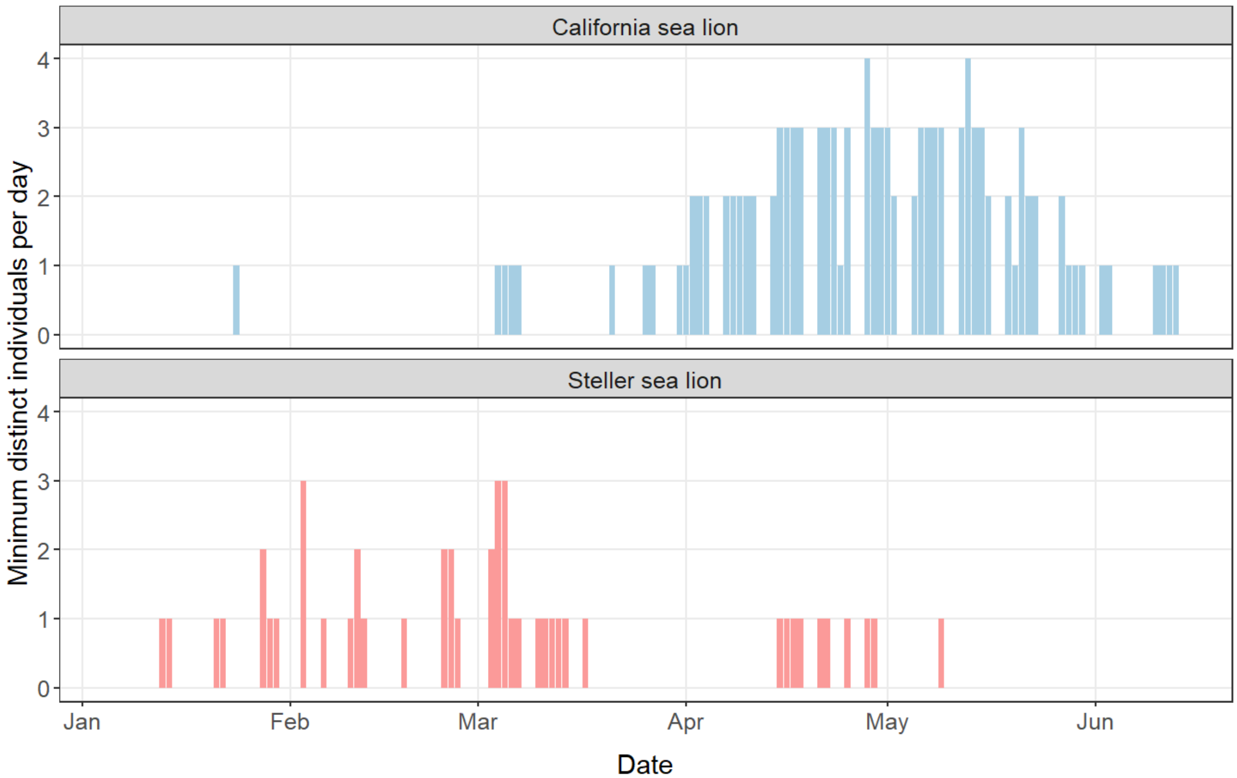


Figure 5. Weekday counts of sea lions at Willamette Falls, January 6–June 13, 2025. Counts include animals observed from the falls downstream to approximately the I-205 bridge.

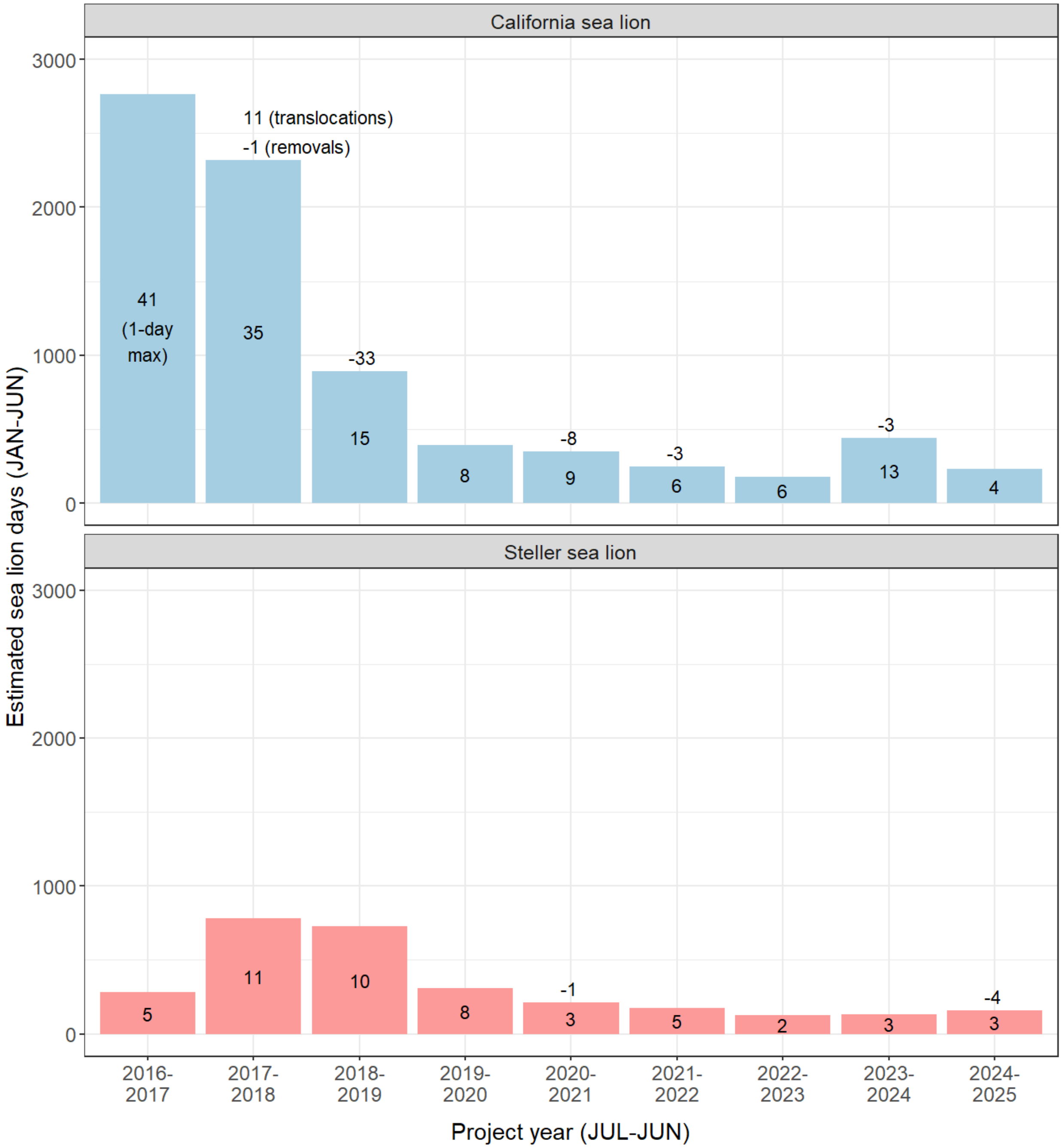
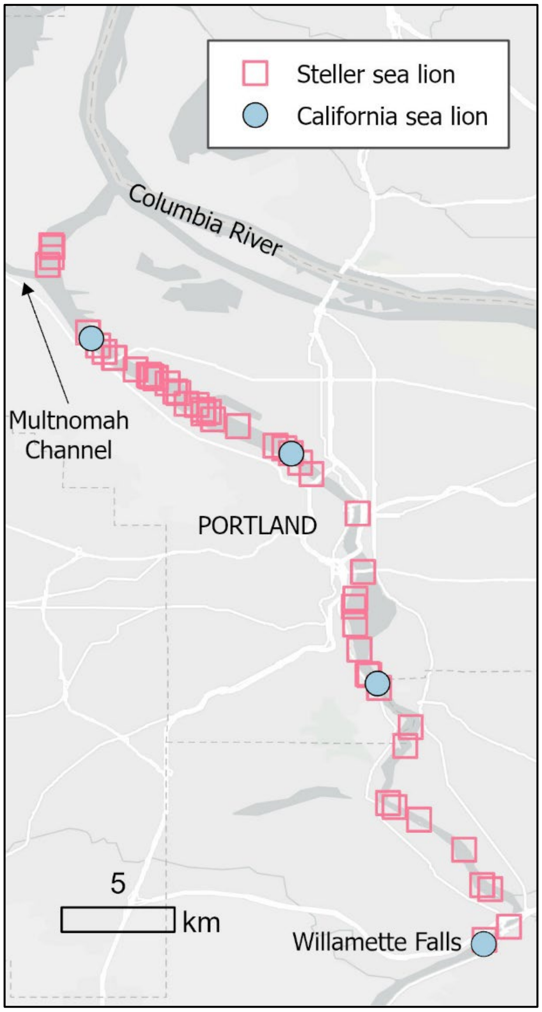


Figure 6. Annual sea lion abundance at Willamette Falls. Bars show cumulative sea lion days during the formal observation period, calculated as the sum of weekly maxima × 7 days per week. The maximum single-day count during the formal study period is shown within each bar, and the number of temporary translocations or permanent removals during the project year is indicated above the bars where applicable.



Date	Survey end	CSL	SSL
2024-09-13	Multnomah Ch.		
10-04	Multnomah Ch.		
10-18	Columbia R.		3
10-25	Multnomah Ch.		1
11-15	Columbia R.	1	1
11-27	Columbia R.		
12-13	Columbia R.		2
12-27	Columbia R.		3
2025-01-13	Columbia R.		5
02-03	Columbia R.		14
02-12	Columbia R.		10
03-03	Columbia R.		9
03-21	Columbia R.	1	1
04-04	Columbia R.	2	1
04-25	Columbia R.	2	7
05-08	Columbia R.	4	5
05-22	Columbia R.	1	1

Figure 7. Individual locations (map at left) and total counts (table at right) for California sea lions (CSL) and Steller sea lions (SSL) observed during vessel-based surveys of the Willamette River, beginning at Willamette Falls in Oregon City and proceeding downriver to the end location noted in the table.

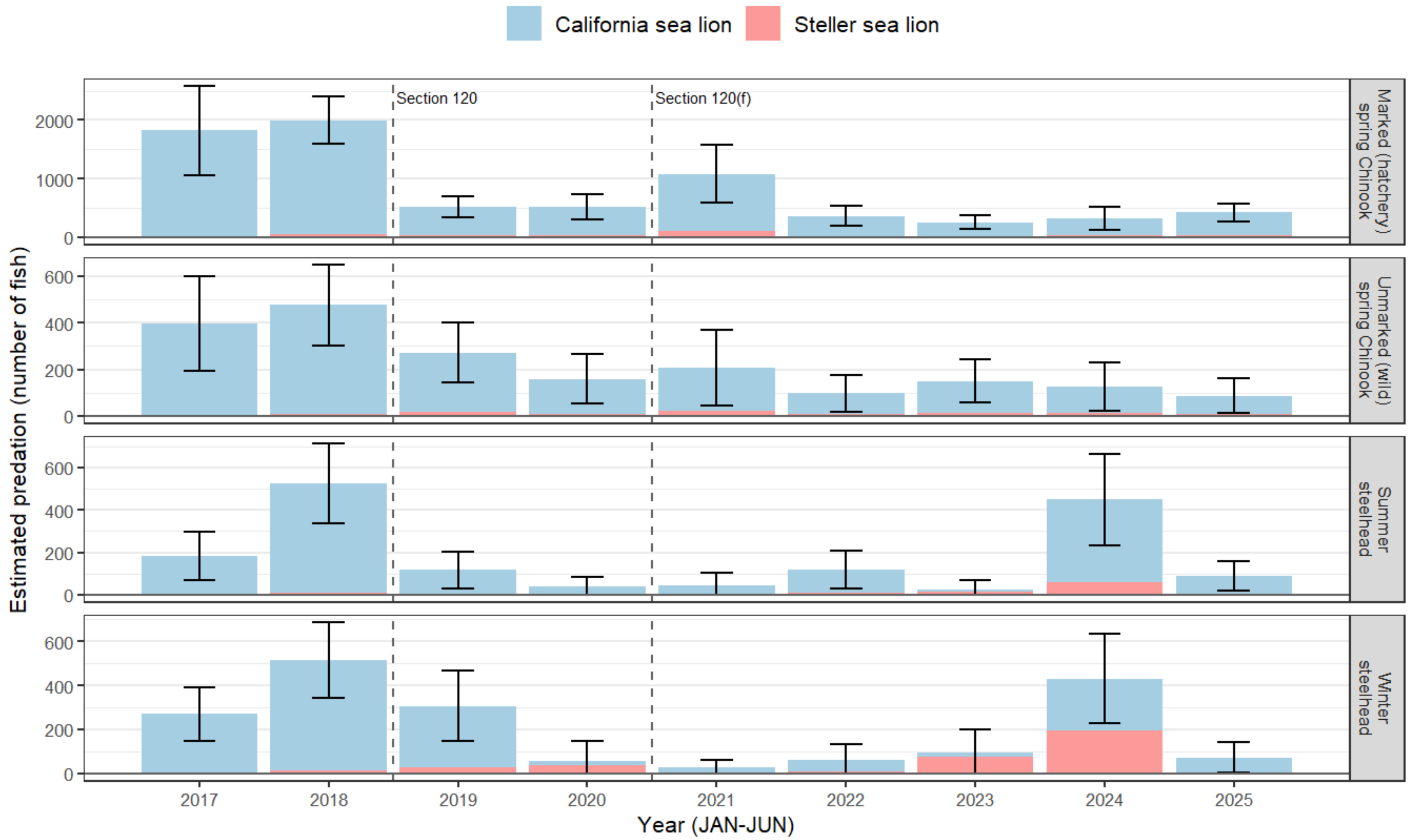


Figure 8. Estimated run-specific salmonid predation by California sea lions and Steller sea lions at Willamette Falls based on Monte Carlo modeling of the probability sample data; 95% confidence intervals are for the combined total (negative lower confidence bounds were replaced with zeros). Estimates apply only to the sampling frames and therefore are minimum estimates due to undercoverage of the target population. Dashed lines indicate sea lion removal authorization dates under Section 120 of the Marine Mammal Protection Act.

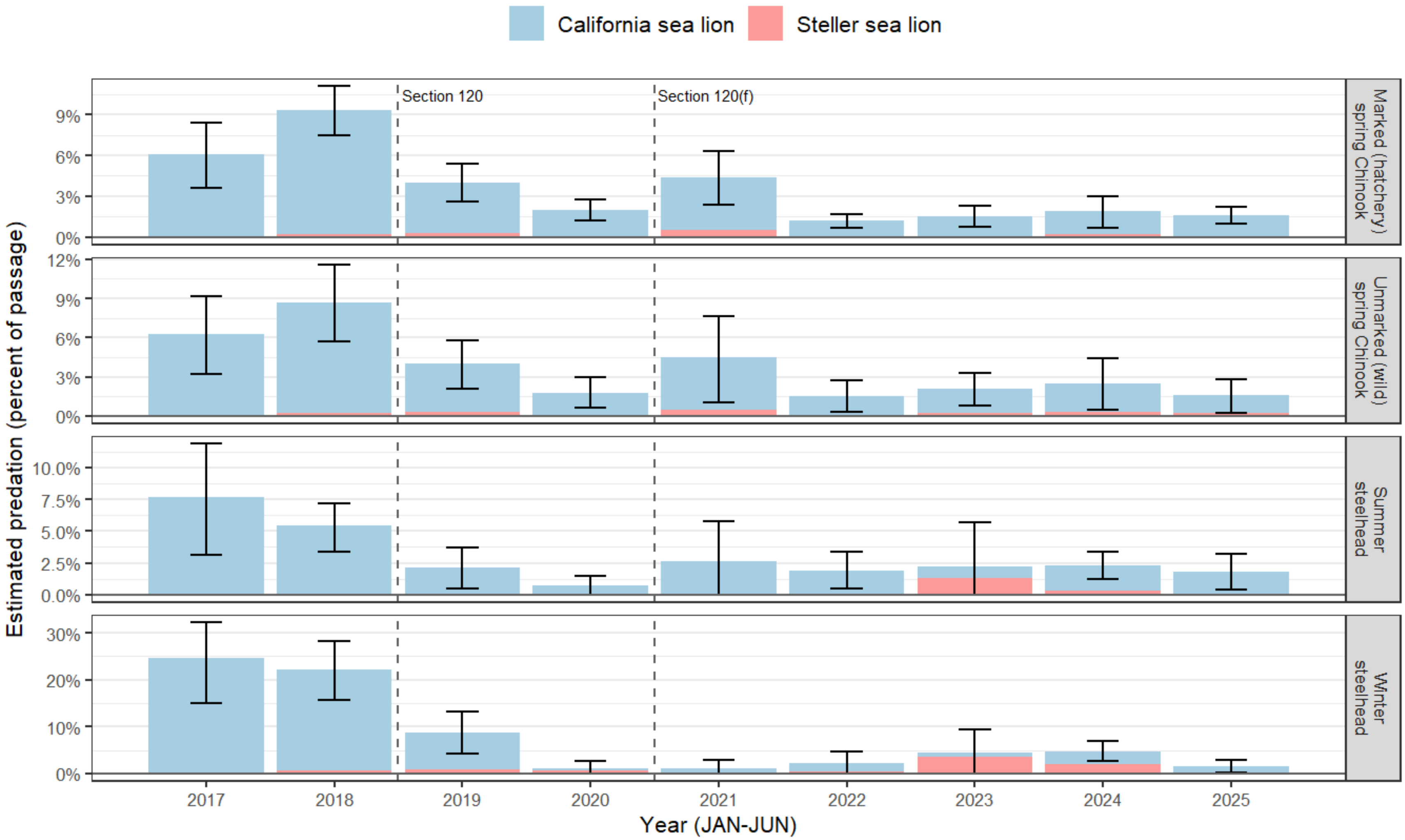


Figure 9. Estimated run-specific salmonid predation expressed as a percent of potential passage above the falls by California sea lions and Steller sea lions at Willamette Falls, based on Monte Carlo modeling of the probability sample data; 95% confidence intervals are for the combined total (negative lower confidence bounds were replaced with zeros). Percent potential passage = estimate / (estimate + passage) × 100. Estimates apply only to the sampling frames and, therefore, are minimum estimates due to undercoverage of the target population. Note that 2025 summer steelhead passage is only through 9/7/25.

Table 1. Estimated predation by California sea lions and Steller sea lions at Willamette Falls based on the probability sampling design. Annual totals are directly comparable only for 2017–2025 due to changes in the sampling frame during the first three years of the project. Estimates apply only to the sampling frames and, therefore, are minimum estimates due to undercoverage of the target population.

	Estimated California sea lion predation Total (95% CI)				Estimated Steller sea lion predation Total (95% CI)			
Year	Salmonids	Lamprey	Sturgeon	Other/ unknown	Salmonids	Lamprey	Sturgeon	Other/ unknown
2014	3690	493	19	20	0	0	37	0
	(3321-4059)	(361-624)	(1*-54)	(2-37)	NA	NA	(2*-108)	NA
2015	5775	758	0	106	0	0	34	0
	(5096-6455)	(531-984)	NA	(36-177)	NA	NA	(0*-80)	NA
2016	4585	1254	0	45	15	0	15	0
	(3680-5490)	(696-1813)	NA	(3*-111)	(1*-43)	NA	(1*-43)	NA
2017	2673	747	0	0	0	0	15	0
	(1658-3688)	(415-1078)	NA	NA	NA	NA	(1*-43)	NA
2018	3435	687	0	0	75	15	194	0
	(3019-3850)	(515-859)	NA	NA	(22-127)	(1*-43)	(28-360)	NA
2019	1120	508	0	0	90	45	60	0
	(963-1277)	(118-897)	NA	NA	(25-154)	(3*-90)	(3-117)	NA
2020	702	134	0	30	75	0	60	30
	(479-924)	(37-232)	NA	(2*-86)	(5*-163)	NA	(10-109)	(2*-86)
2021	1227	443	0	68	136	68	102	0
	(844-1610)	(242-644)	NA	(2*-150)	(2*-311)	(3*-148)	(3-201)	NA
2022	597	105	0	15	45	30	105	0
	(406-789)	(43-166)	NA	(1*-43)	(3*-98)	(2*-68)	(28-182)	NA
2023	403	254	0	15	119	45	0	15
	(296-510)	(92-416)	NA	(1*-43)	(2-237)	(3*-106)	NA	(1*-43)
2024	1030	329	0	0	299	0	0	15
	(688-1373)	(77-580)	NA	NA	(166-432)	NA	NA	(0*-43)

Table 1. Continued.

	Estimated California sea lion predation Total (95% CI)				Estimated Steller sea lion predation Total (95% CI)			
Year	Salmonids	Lamprey	Sturgeon	Other/ unknown	Salmonids	Lamprey	Sturgeon	Other/ unknown
2025	627	75	0	15	45	0	15	0
	(528-727)	(8-141)	NA	(2*-43)	(3*-106)	NA	(1*-43)	NA

*Negative lower confidence bounds were replaced with observed values.

Table 2. Estimated run-specific salmonid predation by California sea lions at Willamette Falls based on Monte Carlo modeling of the probability sample data. Annual totals are directly comparable only for 2017–2025 due to changes in the sampling frame during the first three years of the project. Estimates apply only to the sampling frames and, therefore, are minimum estimates due to undercoverage of the target population. Percent potential passage (%PE) = estimate / (estimate + passage) × 100.

Year	Winter steelhead		Summer steelhead		Unmarked spring Chinook salmon		Marked spring Chinook salmon	
	Total (95% CI)	%PE (95% CI)	Total (95% CI)	%PE (95% CI)	Total (95% CI)	%PE (95% CI)	Total (95% CI)	%PE (95% CI)
2014	780 (563-998)	12.7% (9.5%-15.7%)	710 (499-922)	3% (2.1%-3.9%)	496 (349-643)	7.2% (5.2%-9.1%)	1704 (1413-1994)	6.7% (5.6%-7.8%)
2015	561 (370-752)	11.1% (7.6%-14.3%)	172 (74-270)	4.2% (1.9%-6.5%)	901 (668-1133)	9.1% (6.9%-11.2%)	4142 (3594-4689)	9% (7.9%-10%)
2016	916 (635-1196)	13.7% (9.9%-17.2%)	767 (543-990)	3.4% (2.4%-4.4%)	651 (436-866)	8.9% (6.2%-11.5%)	2252 (1744-2759)	8.7% (6.9%-10.4%)
2017	270 (148-392)	24.7% (15.2%-32.3%)	180 (68-291)	7.6% (3.1%-11.8%)	397 (196-599)	6.3% (3.2%-9.2%)	1826 (1064-2588)	6.1% (3.6%-8.4%)
2018	503 (351-655)	21.6% (16.1%-26.4%)	517 (341-694)	5.3% (3.5%-6.9%)	467 (308-627)	8.5% (5.8%-11.1%)	1947 (1589-2304)	9.1% (7.5%-10.6%)
2019	280 (156-405)	8% (4.6%-11.2%)	109 (32-186)	2% (0.6%-3.4%)	254 (149-358)	3.7% (2.2%-5.2%)	477 (345-608)	3.7% (2.7%-4.7%)
2020	22 (0*-51)	0.4% (0%*-0.9%)	34 (0*-73)	0.6% (0%*-1.3%)	151 (60-242)	1.7% (0.7%-2.7%)	495 (318-671)	1.9% (1.2%-2.6%)
2021	25 (0*-60)	1.2% (0%*-2.8%)	44 (0*-102)	2.5% (0%*-5.6%)	186 (56-316)	4.0% (1.2%-6.5%)	971 (629-1314)	3.9% (2.5%-5.2%)
2022	50 (0*-102)	1.8% (0%*-3.5%)	110 (34-185)	1.8% (0.6%-3.0%)	90 (23-156)	1.4% (0.4%-2.3%)	348 (212-485)	1.1% (0.7%-1.6%)
2023	18 (0*-44)	0.9% (0%*-2.1%)	10 (0*-25)	0.9% (0%*-2.2%)	138 (65-212)	1.9% (0.9%-2.9%)	237 (144-329)	1.4% (0.9%-2.0%)
2024	237 (131-342)	2.6% (1.5%-3.7%)	389 (228-549)	2% (1.2%-2.8%)	110 (28-193)	2.2% (0.6%-3.8%)	295 (127-463)	1.7% (0.7%-2.6%)

Table 2. Continued.

Year	Winter steelhead		Summer steelhead		Unmarked spring Chinook salmon		Marked spring Chinook salmon	
	Total (95% CI)	%PE (95% CI)	Total (95% CI)	%PE (95% CI)	Total (95% CI)	%PE (95% CI)	Total (95% CI)	%PE (95% CI)
2025	72 (6-137)	1.5% (0.1%-2.9%)	86 (23-150)	1.7%** (0.5%-3.0%)	78 (19-137)	1.4% (0.3%-2.4%)	391 (289-494)	1.5% (1.1%-1.9%)

*Negative lower confidence bounds were replaced with zeros.

**Summer steelhead passage through 9/7/25.

Table 3. Estimated run-specific salmonid predation by Steller sea lions at Willamette Falls based on Monte Carlo modeling of the probability sample data. Annual totals are directly comparable only for 2017–2025 due to changes in the sampling frame during the first three years of the project. Estimates apply only to the sampling frames and, therefore, are minimum estimates due to undercoverage of the target population. Percent potential passage (%PE) = estimate / (estimate + passage) × 100.

Year	Winter steelhead		Summer steelhead		Unmarked spring Chinook salmon		Marked spring Chinook salmon	
	Total (95% CI)	%PE (95% CI)	Total (95% CI)	%PE (95% CI)	Total (95% CI)	%PE (95% CI)	Total (95% CI)	%PE (95% CI)
2014	0 NA	0 NA	0 NA	0 NA	0 NA	0 NA	0 NA	0 NA
2015	0 NA	0 NA	0 NA	0 NA	0 NA	0 NA	0 NA	0 NA
2016	4 (0*-13)	0.1% (0%*-0.2%)	3 (0*-8)	<0.1% (0%*-<0.1%)	5 (0*-13)	0.1% (0%*-0.2%)	7 (0*-20)	<0.1% (0%*-0.1%)
2017	0 NA	0 NA	0 NA	0 NA	0 NA	0 NA	0 NA	0 NA
2018	12 (0*-34)	0.6% (0%*-1.8%)	9 (0*-24)	0.1% (0%*-0.3%)	9 (0*-23)	0.2% (0%*-0.5%)	45 (1-89)	0.2% (0%*-0.5%)
2019	27 (0*-63)	0.8% (0%*-1.9%)	6 (0*-18)	0.1% (0%*-0.3%)	17 (0*-42)	0.3% (0%*-0.6%)	40 (0*-86)	0.3% (0%*-0.7%)
2020	37 (0*-96)	0.7% (0%*-1.7%)	3 (0*-8)	0.1% (0%*-0.2%)	9 (0*-24)	0.1% (0%*-0.3%)	26 (0*-60)	0.1% (0%*-0.2%)
2021	1 (0*-2)	<0.1% (0%*-0.1%)	1 (0*-4)	0.1% (0%*-0.2%)	21 (0*-52)	0.5% (0%*-1.1%)	113 (0*-260)	0.5% (0%*-1.1%)
2022	12 (0*-31)	0.4% (0%*-1.1%)	8 (0*-22)	0.1% (0%*-0.4%)	6 (0*-17)	0.1% (0%*-0.3%)	19 (0*-45)	0.1% (0%*-0.1%)
2023	75 (0*-157)	3.6% (0%*-7.2%)	15 (0*-43)	1.3% (0%*-3.6%)	12 (0*-31)	0.2% (0%*-0.4%)	18 (0*-45)	0.1% (0%*-0.3%)
2024	195 (97-292)	2.1% (1.1%-3.2%)	59 (4-114)	0.3% (0%*-0.6%)	15 (0*-37)	0.3% (0%*-0.7%)	30 (0*-66)	0.2% (0%*-0.4%)

Table 3. Continued.

Year	Winter steelhead		Summer steelhead		Unmarked spring Chinook salmon		Marked spring Chinook salmon	
	Total (95% CI)	%PE (95% CI)	Total (95% CI)	%PE (95% CI)	Total (95% CI)	%PE (95% CI)	Total (95% CI)	%PE (95% CI)
2025	1	<0.1%	3	0.1%**	9	0.2%	31	0.1%
	(0*-4)	(0%*-0.1%)	(0*-10)	(0%*-0.2%)	(0*-25)	(0%*-0.4%)	(0*-77)	(0%*-0.3%)

*Negative lower confidence bounds were replaced with zeros.

**Summer steelhead passage through 9/7/25.

Appendix A. Sampling design metadata describing the Willamette Falls sea lion monitoring program, 2014–2025.

Year	Stratum	Sites	Full-time staff	Dates	Weeks	Hours	*N* PSUs	*M* SSUs	*K* TSUs	Frame clusters	*n* PSUs	*m* SSUs	*k* TSUs	Sample clusters	Sampling fraction	Sampling weight	Frame elements	Sample elements	Elements per cluster
2014	F	3	2	Mar 3 - Jun 1	13	1,001	7	7	16	784	5	2	12	120	15.3%	6.53	6,006	929	7.66
	R	9	2	Mar 3 - Jun 1	13	1,001	7	20	16	2,240	5	2	12	120	5.4%	18.67	18,018	966	8.04
		12	4							3,024				240	7.9%		24,024	1,895	
2015	F	6	2	Feb 9 - May 31	16	1,239	7	14	16	1,568	5	2	12	120	7.7%	13.07	14,868	1,101	9.48
	R	10	2	Feb 9 - May 24	15	1,155	7	22	16	2,464	5	2	12	120	4.9%	20.53	23,100	1,122	9.37
		16	4							4,032				240	6.0%		37,968	2,223	
2016	F	6	2	Feb 1 - May 29	17	1,389	7	16	16	1,792	5	2	12	120	6.7%	14.93	16,668	1,114	9.30
2017	F	6	2	Jan 9 - Jun 9	22	1,750	7	16	16	1,792	5	2	12	120	6.7%	14.93	21,000	1,413	11.71
2018	F	6	2	Jan 8 - Jun 3	21	1,653.5	7	16	16	1,792	5	2	12	120	6.7%	14.93	19,842	1,337	11.14
2019	F	6	2	Jan 7 - Jun 2	21	1,647	7	16	16	1,792	5	2	12	120	6.7%	14.93	19,764	1,327	11.05
2020	F	6	2	Jan 6 - May 31	21	1,642.5	7	16	16	1,792	5	2	12	120	6.7%	14.93	19,710	1,329	11.08
2021	F	6	1	Jan 4 - May 30	21	1,636	na	na	na	3,272	na	na	na	96	2.9%	34.08	19,632	576	6
2022	F	6	1	Jan 3 - Jun 5	22	1,721.5	7	16	16	1,792	5	2	12	120	6.7%	14.93	20,658	1,388	11.6

Appendix A. cont.

Year	Stratum	Sites	Staff	Dates	Weeks	Hours	*N* PSUs	*M* SSUs	*K* TSUs	Frame clusters	*n* PSUs	*m* SSUs	*k* TSUs	Sample clusters	Sampling fraction	Sampling weight	Frame elements	Sample elements	Elements per cluster
2023	F	6	1	Jan 2 – May 28	21	1,624.5	7	16	16	1,792	5	2	12	120	6.7%	14.93	19,494	1,289	10.7
2024	F	6	1	Jan 1 – Jun 2	22	1,710	7	16	16	1,792	5	2	12	120	6.7%	14.93	20,520	1,375	11.5
2025	F	6	1	Jan 6 – Jun 16	23	1,828	7	16	16	1,792	5	2	12	120	6.7%	14.93	21,936	1,460	12.2