

Results of the 2022 Survey of the Sea Otter Population in Washington State



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Introduction

Northern sea otters, *Enhydra lutris kenyoni* (hereafter sea otter or otter), historically ranged throughout much of the coastal North Pacific. In the western North Pacific Ocean, sea otters could be found from the northern islands of Japan through the Commander and Aleutian Islands, including areas as far north as the Pribilof Islands. In the eastern North Pacific Ocean, sea otters ranged from the Alaska Peninsula south along the coast to Oregon (Wilson et al. 1991). In Washington, areas of sea otter concentration were reported from the Columbia River north along the coast of the Olympic Peninsula (Scheffer 1940). Washington's sea otter population was extirpated through hunting by the early 1900s. In an effort to reintroduce otters to Washington, sea otters were captured at Amchitka Island, Alaska, in 1969 and 1970 and translocated to states/provinces where they had been extirpated, including locations in Alaska, British Columbia, Washington, and Oregon. In Washington, a total of 59 sea otters were translocated to the outer coast of the Olympic Peninsula, with 29 individuals released near Point Grenville in 1969 and an additional 30 otters released near La Push in 1970 (Jameson et al. 1982; Jameson et al. 1986). In 2004, Washington State published a recovery plan for sea otters (Lance et al. 2004), and the status of the Washington sea otter population is reviewed by the WDFW every five years (for the most recent status review see Sato et al. 2018). Sea otters are currently listed as a Threatened species in the State of Washington and are protected under the Marine Mammal Protection Act of 1972.

Since 1989, aerial and ground surveys have been conducted by WDFW and USFWS/USGS to monitor Washington's sea otter population. Only three years of counts are missing from this time series – 2009 due to poor weather conditions, 2018 due to lack of funding, and 2020 due to the COVID-19 pandemic. In 1989, the population was estimated to be 208 sea otters, living primarily in the rocky habitats north of La Push, but with a small number counted as far south as Destruction Island. By 2019, the population had grown to at least 2,785 otters (Jeffries et al. 2019). During this time, sea otters have continued to occupy the primary range between Point Grenville and Cape Flattery, with population growth occurring within this range. Extralimital reports of sea

otters which most likely originated from this population have come from Oregon, as far south as Cape Arago, in the Strait of Juan de Fuca, San Juan Islands, Admiralty Inlet, Bellingham Bay, and southern Puget Sound. A translocated population of sea otters also occurs along the outer Vancouver Island coast from Barkley Sound to Cape Scott.

Methods

Survey Protocol

Sea otter aerial surveys were flown in WDFW's Partenavia P-68C-TC (N 357 PN) (Figure 1) or in a contracted Cessna 206 and cover coastal waters within the historical range of sea otters in Washington. A reconnaissance flight from Tillamook Rock, OR (45.3852° N –124.0184° W), north to Cape Flattery, WA (48.3861° N; –124.7261° W), then east into the Strait of Juan de Fuca to Freshwater Bay (48.1432° N; –123.6089° W), WA, is typically conducted the day prior to beginning surveys to establish sea otter distribution and investigate the possibility of range expansion. This reconnaissance flight is then followed by three consecutive days of surveys covering coastal waters from just north of Grays Harbor, WA, at Copalis Rocks (47.2952° N; –124.2610° W) to Cape Flattery, and then east in the Strait of Juan de Fuca to Freshwater Bay. For discussion purposes, this survey area is broken up into a southern segment (from La Push south) and northern segment (from La Push north and into the Strait of Juan de Fuca).

Surveys were flown at approximately 800–1000' Above Ground Level (AGL) following a trackline along the coast about 0.5 mile from shore, allowing observation of a strip from the shoreline to ~2 miles offshore. This trackline covered all kelp beds and nearshore rocks and reefs along the outer Washington coast from Copalis Rocks north into the Strait of Juan de Fuca. The flight crew consisted of the pilot and three observers – a primary observer, secondary observer/data recorder, and a tertiary observer. The primary observer sat in the right front seat and was responsible for locating otters and directing the pilot; photographing otters with a digital camera (Canon EOS 7D Mark II equipped with a 100–400 mm lens); and counting (groups < 25 otters) or estimating (groups >25 otters) group size. The secondary observer in the right rear seat looked for otters, especially individuals or small groups near to but not part of large groups, and recorded times, counts, locations, and photo numbers on a flight log. The tertiary observer sat in the rear left seat, focusing on locating offshore groups and otters that the primary and secondary observers may have missed while focusing on the right side of the plane. For larger groups of sea otters, the aircraft circled clockwise to enable the primary observer to estimate numbers of otters and take digital photos without glare from the sun. For safety purposes, Automatic Flight Following (AFF) was used to track real-time locations for the aircraft. A Garmin GPSmap76Cx was used to record track lines. In 2022, the ArcGIS Collector app was run on a tablet and used as additional tool to help orient observers. The Collector app was not used to record data, but provided the plane's position in real time displayed on a map of the Washington coast.

To address questions that developed from the 2021 surveys about possible use of offshore habitat by Washington's sea otters, two offshore survey legs were added to all 2022 surveys (Figure 2). These offshore legs began at the western tip of Destruction Island and ran south ~4 miles from the beach, with observers scanning for otters on both the on- and offshore sides of the

plane. When the plane was just north of Split and Willoughby Rocks, it turned inland until it was ~2 miles offshore, at which point it began a south-to-north transect maintaining a distance of ~2 miles from the beach. Upon returning to the Destruction Island area, the traditional onshore flight path was resumed for the remainder of the survey. As in the traditional survey approach, the plane deviated from the transect line to count all otters sighted. Groups of otters using offshore habitat but sighted from the traditional inshore survey line were counted as “inshore” otters, as they would have been captured by the survey even if the offshore transects were not flown. Otters seen on either the ~4 or ~2 mile offshore legs were categorized as “offshore” sightings to determine how many additional otters were seen by including the offshore component in 2022. The track line and map displayed on the ArcGIS Collector app were used to avoid double counting of any groups during the offshore legs.

Ground-based Surveys

Teams of ground observers conducted shore-based, visual surveys of nearshore sea otter habitat at five locations on the Washington Coast using binoculars and spotting scopes. From north to south, these locations included Sand Point, Norwegian Memorial, on the Quinault Indian Nation inshore of Split and Willoughby rocks, Giants Graveyard, and Kalaloch Lodge. A full count of the viewable area was conducted by ground observers within approximately 30 minutes of the aerial observations of the same location. Observations of adults (independent) and large or small pups (dependent) were recorded on a topo or aerial photo delineated with the viewable area during each count (noting visual obstructions and environmental conditions that limit visibility during the count). Ground observers also recorded weather conditions, otter behaviors, their assessment of the accuracy of the count and any potential disturbance (boats, kayaks, response to aircraft, predators, etc.) that occurred during the count.

Photo Counts and Analyses

All digital images of groups of otters taken during the aerial surveys were reviewed and the best photo of each group was identified for use in counting. The best photos are those that are in focus, at an appropriate zoom, have minimal sun glare, and ideally capture the otters rafted at the surface, not swimming directionally or diving. Authors counted adults and pups in the digital images using Image J 1.5i (<http://imagej.nih.gov/ij>) and collectively agreed on the number of otters in each photo. Photo counts only included otters that were distinguishable (e.g., submerged objects that could not be confidently identified as otters were not counted). Pups identified within digital images were distinguished from adults and classified as dependent based on their small size, wooly light brown pelage, and close association/orientation (generally resting on the chest) with an adult.

Counts of adults and pups from the digital images were then added to the counts of otters observed during the survey but not photographed (groups smaller than ~25 individuals) to obtain the full count of sea otters from the aerial surveys. The final estimate consists of the most accurate aerial count of larger groups and estimates of small groups or individuals made during the aerial survey.

Once a total count was calculated for each flight conducted, the flight with the highest total count was selected as the annual estimate. The resulting estimates represent the minimum Washington population count, because there is no correction factor to account for individual animals or small groups off the flight path, outside of the survey area, or underwater when the plane flew over. Variance and/or confidence limits for these estimates cannot be calculated because annual estimates are based on the single highest count with no correction factors.

The average rate population change (% increase or decrease) was calculated from annual counts from 1989 to 2022, and an exponential curve was fit to the count data. This approach provides an estimate of sea otter population growth based on all years in the time series, but also allows prediction across gaps in the dataset (i.e., 2009, 2018, 2020) and assessment of model fit using the R^2 value. An exponential model was chosen because it outperformed other methods (e.g., linear model, 2nd or 3rd order polynomial model) and because it is biologically relevant to a depleted or introduced wildlife population in the early stages of growth towards carrying capacity (Snider and Brimlow 2013). A 3-year moving average is included in the Appendix for comparison with previous reports (Supplementary Figure 1).

Results

Washington sea otter surveys are a collaborative effort between biologists and volunteers from the Washington Department of Fish and Wildlife, U.S. Fish and Wildlife Service, Olympic Coast National Marine Sanctuary, Olympic National Park, The Seattle Aquarium, Point Defiance Zoo and Aquarium, the Quinault Indian Nation, and the University of Washington.

2022 Survey Details

The 2022 sea otter surveys were flown during the week of June 20 – 24, 2022. A reconnaissance flight was conducted on June 20, beginning at Tillamook Rock in Oregon, but halting ~2 miles North of James Island (La Push) due to foggy conditions. Though the reconnaissance flight is typically aimed at determining only the overall distribution of sea otters within the survey area, 2022 was the first year in which the longstanding survey lead (Steve Jeffries) did not participate sea otter surveys. Thus, the first flight in 2022 was taken as an opportunity for the survey crew to practice spotting, counting, and photographing sea otters and was treated both as a reconnaissance flight and a traditional survey, with group size estimates and photographs taken for each group of otter sighted. All observers were trained by former survey lead Steve Jeffries and had prior experience conducting aerial surveys of marine mammals in Washington.

Inclement weather precluded surveys on June 21, 2022, but complete surveys were flown June 22 – 24, 2022. Sighting conditions remained relatively poor during the June 22 survey due primarily to wind, but substantially improved on June 23 and 24. The 2022 survey crew consisted of M. Kimbrel (pilot), C. Clark (primary observer, right front seat), S. Ament (secondary observer/data recorder, right rear seat), and C. Pasi (tertiary observer, left rear seat). C. Pasi was unable to participate in the survey on June 24, 2022, so an alternate observer (S. Colosimo) acted as tertiary observer on that day.

Photo Counts

Only the photos from June 20 and 23, 2022, were counted due to the poor sighting conditions on June 22, and the combination of lower estimated otter abundance, lack of ground counts, and different aerial observer composition on June 24. The June 20 reconnaissance flight included a survey of the southern portion of the Washington sea otter range, but was aborted just north of La Push due to persistent fog and low clouds. This survey also included two offshore legs between Destruction Island and Split/Willoughby Rocks that were new additions to the 2022 surveys, one ~4 miles offshore flown north to south, and the other flown south to north ~2 miles off the beach (Figure 2A). The June 23 flight was a complete survey of the Washington sea otter range, from Copalis Rocks to Cape Flattery, then east into the Strait of Juan de Fuca ending at Freshwater Bay. This survey also included the additional legs introduced in 2022 to evaluate the use of offshore habitat by Washington's sea otters (Figure 2B). Both surveys covered the nearshore waters, reefs, and kelp beds, as well as offshore rocks and islands. Observation conditions on both days were very good or excellent.

The number of sea otters observed during the survey conducted on June 20, 2022, was 2,916. This included 1,788 otters observed from the traditional nearshore flight path and 1,128 otters seen on the new offshore survey legs. These numbers do not include the area north of La Push, as that area was not surveyed due to poor weather conditions. During the June 23, 2022, survey, a total of 2,163 otters were observed, including 1,415 individuals seen from the nearshore flight path in the area south of La Push, 4 on the new offshore legs in the southern portion of the range, 744 in the area north of La Push. (Tables 1 and 2). The June 20, 2022, survey of the southern segment of the WA sea otter range included 41 pups, none of which were observed on the offshore legs. The survey of the complete range on June 23, 2022, recorded 67 pups which were also only seen on the inshore component of the survey. Of these 67 pups, 31 were observed south of La Push and 36 were observed in the northern segment of the range. On June 23, 1,415 otters were counted in the southern segment of the range and 744 in the northern segment, putting ~65% of otters counted south of La Push and ~35% of otters in the northern segment. Taken in tandem with the low counts in 2021, these results would indicate a continued a reversal of the long-term trend of an increasing proportion of the population being present in the southern segment than in the northern segment; however, the presence of 2,916 sea otters in just the southern segment of the range on June 20 confirms suspicions that the 2021 count of 1,811 otters throughout their range was unrealistically low. If instead the June 20 count from the southern segment combined with the June 23 count of the northern segment for these calculations, the result is ~80% of the population in the southern segment and ~20% north of La Push, which is more closely in line with the longstanding trend (Figures 5 and 6). The exponential fit for the minimum abundance of sea otters in Washington from 1989 – 2022 was lower than previously reported ($R^2 = 0.899$), reflecting the large fluctuations in estimates in recent years.

The protocols used for aerial surveys of Washington's sea otter population dictate that the survey with the highest count of individual sea otters be selected as the minimum population estimate for that year. In 2022, the partial survey conducted on June 20 counted 753 more sea otters than were seen during the complete survey of the Washington sea otter range conducted on

June 23. To remain conservative in the generation of minimum abundance estimates for Washington's sea otter population, the count of 2,916 otters from the June 20 survey was selected as the minimum population estimate for 2022; however, it is important to note that this is only for the southern segment and is therefore almost certainly a substantial estimate of total otter abundance in Washington.

Ground observers conducted 15 separate counts of sea otters at five locations on the Washington Coast (Table 3). Of these, five counts (one at each location) occurred within 30 minutes of the overflight by the survey plane, all on June 23, 2023. No shore-based counts occurred on June 20, as ground observers were not in place on that day. Sea otter counts conducted from the airplane resulted in larger numbers of otters at four of the sites when ground and aerial counts were conducted at the same time, though the difference between the counts was typically small (mean $\pm$ 1 standard deviation = 11.4 ± 18.3). Ground counts typically counted more pups than were observed from the plane (mean $\pm$ 1 standard deviation = 4.6 ± 6.6) and were able to classify dependent sea otters as large pups or small pups, which could not be reliably accomplished from aerial photographs or observations.

Discussion

As was the case in 2021, the results of the 2022 survey of the Washington sea otter present a challenge to interpretation. Multiple complicating factors limit the inference that can be drawn from the 2022 surveys, including the occurrence of the highest count on a day when only the southern portion of the Washington sea otter range could be surveyed, lower counts on subsequent complete surveys of the range, and the inconsistent presence of as many as 1,128 otters in the offshore area between Destruction Island and Split and Willoughby rocks. It is unclear what the total count for 2022 would have been if the northern part of the range were successfully flown on June 20. Surveys from 2019, 2021, and 2022 (June 23) included counts of 549, 595, and 744 sea otters north of La Push, respectively, and none of the surveys conducted since the beginning of the time series in 1989 counted fewer than 175 otters in that region. The minimum population estimate for 2022 is therefore almost certainly biased low. Though very likely an underrepresentation of the abundance of sea otters in Washington, the documentation of 2,916 otters during the partial count of the Washington sea otter range on June 20, 2022, confirms that the 2021 count was lower than the actual abundance and did not represent a population decline.

The factors responsible for the inconsistent counts among individual surveys in 2022 remain poorly understood; however, the use of offshore habitat by a large portion of the population is a likely driver of the observed patterns. While possible, it is very unlikely that most or all of the sea otters from the area north of La Push moved into the southern portion of the range on June 20, thus resulting in higher counts in this area than in the entire range on June 23. The inclement weather that precluded surveys on June 21 and contributed to poor sighting conditions on June 22 did result in noticeable changes in the behavior and distribution of sea otters on the Washington coast during the June 22 flight, with otters observed either scattered in open water or rafted in the lee of islands and offshore rocks. This redistribution may have been responsible for the considerable variability in otter counts on the new offshore survey legs. On the offshore legs, 1,128

otters were seen on June 20 and only 4 detected on June 23. The area between Destruction Island and Split and Willoughby rocks was selected as a location to pilot additional offshore survey legs because large rafts had been spotted in this offshore location in previous years; however, there is no reason to believe that this is the only segment of offshore habitat on the Washington coast used by sea otters.

Ground observations were conducted as part of the 2022 survey of the Washington sea otter population for the first time since 2019. Previous efforts to reconcile counts between shore-based surveys and aerial observations involved ground observers mapping the locations of otters and comparing those with data collected from the airplane. This process was labor intensive, though it typically resulted in a small number of otters missed by the aerial observers being added to the overall count. Given the complications of marrying these two types of data and the great deal of effort required for a relatively small change in the minimum abundance estimates, this approach was not used for this year's survey effort. In 2022, the aerial observations recorded a greater number of otters at four of the five ground survey locations, supporting the idea that this approach is generally more effective for surveying overall abundance. The shore-based observations, however, typically counted more pups than did observations made from the air and were able to divide the pups into broad age classes. Given the additional information including foraging observations and behavioral data that can be gathered by ground observers but not from an airplane, the ground surveys provide a great deal of value to efforts to monitor Washington's sea otter population, even if not used to supplement the estimates of overall abundance.

Given the low count in 2021 and the partial survey used as the high count in 2022, calculating the yearly rate of population growth or decline as has been done in past reports is uninformative. The best approximation of this might be to add the 744 otters counted in the northern portion of the Washington sea otter range on June 23 to the 2,916 otters counted in the southern portion of the range on June 20, then calculate the annual growth rate since the 2019 count. This results in an average annual growth rate of 10.5% since 2019, which closely matches the 10.0% average annual growth rate between 1989 and 2019. This also supports the notion that Washington's sea otter population is much larger than the conservative estimate presented in this report; however, the use of the single highest count of otters seen in one day to be consistent with previous reporting and being conservative in the presentation of abundance data for a Washington State Threatened species.

Between 1989 and 2002, most of the Washington sea otter population was located north of La Push; however, since the late 1990s, the population in the southern segment has been growing at a much faster rate than the population in the northern segment (Figures 5-6). Along with the low counts from 2021, the sea otter counts from the complete survey of the range on June 23, 2022, would indicate a continued reversal of this long-term trend, with a declining proportion of the population in the area north of La Push. However, replacing the June 23 count of otters in the southern segment with those from June 20 closely aligns the proportions of the population north and south of La Push with the long-term trend. This supports the results of the 2021 Washington sea otter survey report which indicated that any large numbers of otters were missed by the 2021 survey were likely located in the southern portion of the range. The likelihood of this is further evidenced by the count of 2,916 otters in this area on June 20, 2022, followed by a count of 1,415

otters in this segment only 3 days later. This information may be valuable in designing future surveys to more effectively estimate the abundance of the Washington sea otter population.

In the northern segment of the survey area, most sea otters raft in locations where *Macrocystis* kelp beds are a prominent feature, such as Sand Point (Figure 7). In contrast, in the southern segment, recent annual surveys have documented multiple large sea otter rafts in open water 1-2 miles offshore between Hoh Head and the Queets River in sandy bottom habitat without kelp beds (Figure 8). During the 2022 survey, the southernmost sighting was a group of five animals including one pup observed near Point Grenville. The northernmost otters were 26 individuals with one pup observed at Tatoosh Island. No otters were observed east of Tatoosh Island in the 2022 surveys. Several credible sightings of sea otters from Washington's inland waters were received in 2022, including otters in the Strait of Juan de Fuca, a moribund otter at Birch Bay State Park, and multiple observations of a single individual otter in Carr Inlet in South Puget Sound. Two dead sea otters were reported on Oregon beaches in 2022, and multiple mortalities occurred there in past years. To the best of our knowledge, no live sea otter pups (or dependents) were observed anywhere in Washington or Oregon waters outside of the survey area.

The primary conclusions from our 2022 survey of the Washington sea otter population are 1) that the population has not begun to decline, despite the low count in 2021, and 2) that updated survey methods are sorely needed to improve the efficacy of these efforts in the future. The methodology currently used to survey sea otters in Washington appears to have been generally effective at capturing a minimum population number and distribution of sea otters along the coast when the population was small; however, as the abundance of sea otters has increased the ability of these surveys to accurately capture the size of the population appears to have diminished. This may, in part, be attributable to increased use of offshore habitat in recent years. Boat-based surveys of the waters off the Washington coast conducted between 2016 and 2022 documented an individual sea otter more than 50km, another more than 47km from land, and a third more than 34km off the beach (WDFW unpublished data), with these sightings ranging as far north as the latitude of Destruction Island and as far south as the latitude of Long Beach Peninsula, Washington. A WDFW report to the United States Navy summarizing the results of pelagic boat-based survey efforts in fall and winter 2019-2020 documented 13 sea otters with an average distance from shore of ~17km (Pearson 2020). Though these sightings likely represent the offshore distribution extremes of a generally coastal species, they support the idea that future surveys should be designed to cover offshore habitat in addition to coastal areas. Future improvements to study design including a switch to a sampling approach to generate actual population abundance estimates with some measure of uncertainty, the use of vertical photography and automated tools for identifying and counting sea otters in photos to increase staff safety and efficiency, and other potential survey modifications are being considered for implementation in 2024 or beyond.

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Tables

Table 1. Results of the partial survey of the Washington sea otter population conducted on 6/20/2022, ending ~2 miles north of La Push. Independent = Adults; Dependent = Large or Small Pups. The “In/Offshore” column indicates whether the counts at a location were part of the traditional inshore survey of the coast or sighted during the ~2 or ~4 mile offshore legs added to the survey in 2022.

<i>Location</i>	<i>In/Offshore</i>	<i>Independent</i>	<i>Dependent</i>	<i>Total</i>
<u>SOUTH SURVEY SEGMENT</u>				
Cape Elizabeth Area	Inshore	99	0	99
Willoughby Rock	Inshore	161	2	163
Raft River Area	Inshore	238	0	238
Queets River	Inshore	1	0	1
Kalaloch Area	Inshore	5	0	5
Destruction Island	Inshore	455	5	460
3 – 4 miles offshore Kalaloch Area	Offshore	211	0	211
2 – 4 miles offshore Raft River Area	Offshore	917	0	917
Abbey Island Area	Inshore	6	0	6
Diamond Rock	Inshore	677	10	687
Perkins Reef	Inshore	40	14	54
Giants Graveyard	Inshore	54	10	64
Quillayute Needles	Inshore	11	0	11
<u>NORTH SURVEY SEGMENT</u>				
North segment not surveyed due to poor weather	-	-	-	-
Inshore Total		1747	41	1788
Offshore Total		1128	0	1128
Partial Survey Total		2875	41	2916

Table 2. Results of the complete survey of the Washington sea otter population conducted on 6/23/2022. Independent = Adults; Dependent = Large or Small Pups. The “In/Offshore” column indicates whether the counts at a location were part of the traditional inshore survey of the coast or sighted during the ~2 or ~4 mile offshore legs added to the survey in 2022.

<i>Location</i>	<i>In/Offshore</i>	<i>Independent</i>	<i>Dependent</i>	<i>Total</i>
<u>SOUTH SURVEY SEGMENT</u>				
Point Grenville Area	Inshore	4	1	5
Cape Elizabeth Area	Inshore	7	1	8
Flat Rock	Inshore	28	2	30
Rock 535 (unnamed rock south of Split Rock)	Inshore	7	0	7
Willoughby Rock	Inshore	235	6	241
Split Rock Area	Inshore	4	0	4
Between Split Rock and Raft River Area	Inshore	19	0	19
Raft River Area	Inshore	188	0	188
Queets River Area	Inshore	17	0	17
Kalaloch Area	Inshore	19	0	19
Destruction Island	Inshore	529	11	540
2 – 4 miles offshore north of Split Rock	Offshore	3	0	3
2 miles offshore SE of Destruction Island	Offshore	1	0	1
Hoh Head Area	Inshore	256	8	264
Diamond Rock	Inshore	1	0	1
Perkins Reef	Inshore	2	0	2
Giants Graveyard	Inshore	43	2	45
Quillayute Needles	Inshore	21	0	21
<u>NORTH SURVEY SEGMENT</u>				
Chilean Monument	Inshore	132	16	148
Sandy Island Area	Inshore	168	0	168
Cedar Creek/Norwegian Memorial	Inshore	60	2	62
Yellow Banks	Inshore	60	7	67
Sand Point	Inshore	128	3	131
Ozette Island	Inshore	32	2	34
Tskawahyah/Cannonball Island	Inshore	94	3	97
Duk Point	Inshore	9	2	11
Tatoosh Island	Inshore	25	1	26
Inshore Total		2092	67	2159
Offshore Total		4	0	4
Survey Total		2096	67	2163

Table 3. Shore-based counts of sea otters conducted by ground observers at five locations in the Washington sea otter range in 2022, including site name, date, total number of otters counted, total adults, large pups, and small pups, as well as sighting conditions during the count. Corresponding sea otter counts from corresponding aerial observations including total number of sea otters, adults, and pups counted from aerial photos and observations are provided a subset of ground counts on June 23, 2022.

Site	Date	Total Otters	Adults	Large Pups	Small Pups	Plane Count Total	Plane Count Adults	Plane Count Pups	Sighting Conditions
<i>Sand Point</i>	6/21/2022	128	109	2	17	-	-	-	Very good, Beaufort 2
" "	6/21/2022	78	68	2	8	-	-	-	Fair, Beaufort 2
" "	6/22/2022	156	142	3	11	-	-	-	Fair
" "	6/22/2022	123	101	3	19	-	-	-	Beaufort 3
" "	6/23/2022	131	105	6	20	-	-	-	Excellent
" "	6/23/2022	124	104	2	18	131	128	3	Very good to good
<i>Norwegian Memorial</i>	6/22/2022	110	107	0	3	-	-	-	Beaufort 2 to 3
" "	6/23/2022	41	41	?	?	54	53	1	Beaufort 1 to 2
<i>Split and Willoughby Rocks</i>	6/22/2022	152	144	3	5	-	-	-	Good, Beaufort 4
" "	6/22/2022	156	152	0	4	-	-	-	Fair, Beaufort 4
" "	6/23/2022	211	203	7	1	245	239	6	Very good to good, Beaufort 3
<i>Giants Graveyard</i>	6/22/2022	48	43	3	2	-	-	-	Excellent, Beaufort 1
" "	6/23/2022	59	50	4	5	45	43	2	Excellent, Beaufort 1
<i>Kalaloch Lodge</i>	6/22/2022	0	0	0	0	-	-	-	"3", Beaufort 4
" "	6/23/2022	0	0	0	0	1	1	0	"4", Beaufort 3



Figure 1. WDFW's Partenavia (N357PN) surveying sea otters over Destruction Island. (Photo: Scott Pearson, WDFW)



Figure 2. Garmin GPSmap76Cx mapping GPS track line from Washington sea otter aerial survey on A) June 20, 2022; B) June 23, 2022. Note the different scales on the two maps.

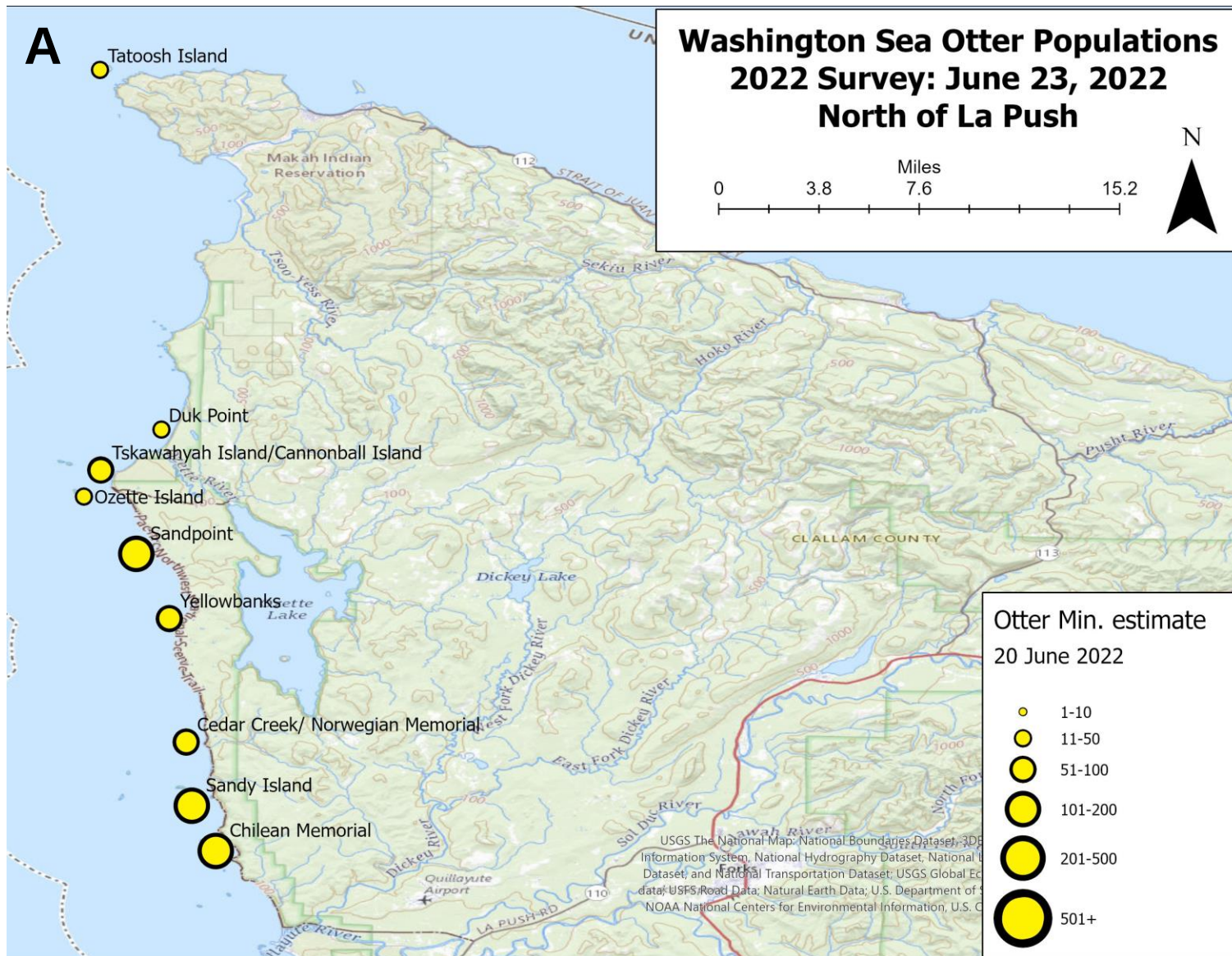


Figure 3A. Washington sea otter population distribution in the northern segment of the range during the survey on June 23, 2023. Sizes of circles correspond to the number of otters counted at that location.

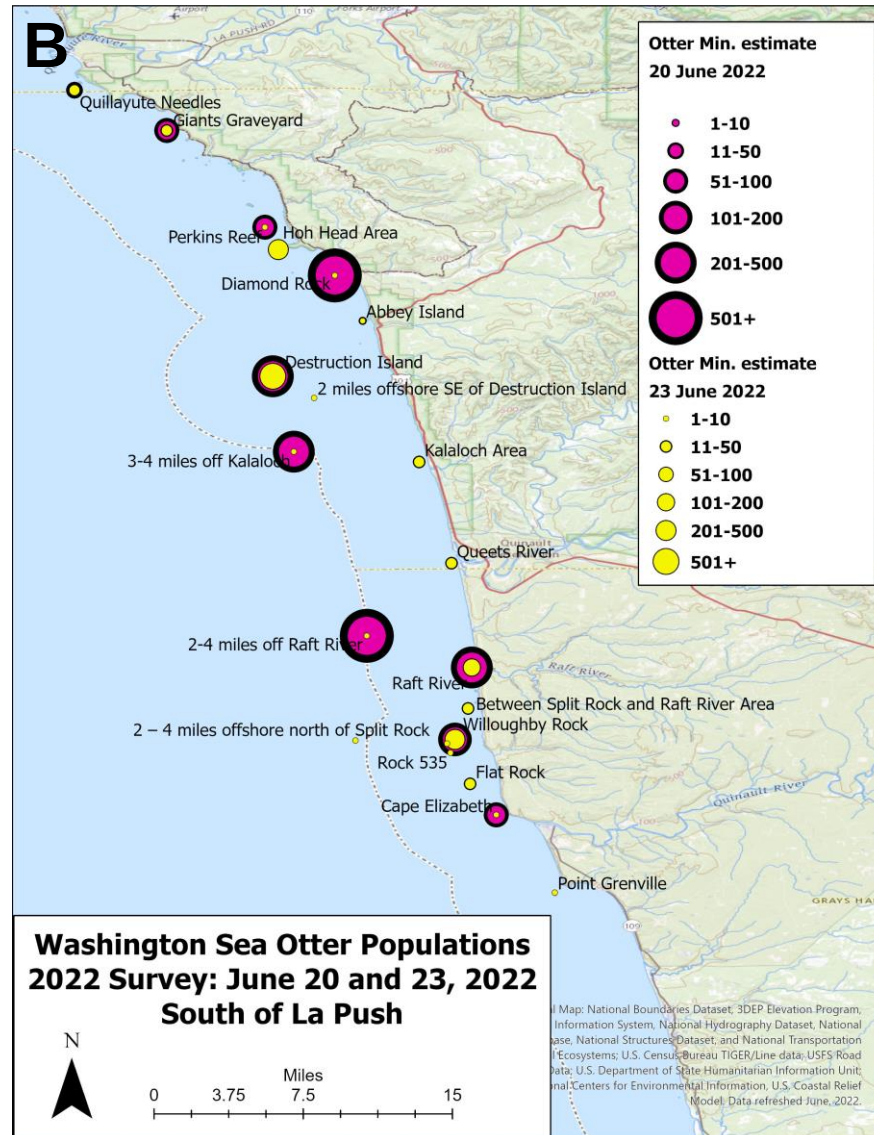


Figure 3B. Washington sea otter population distribution in the southern segment of the range during the surveys on June 20 (pink) and June 23 (yellow), 2023. Sizes of circles correspond to the number of otters counted at that location.

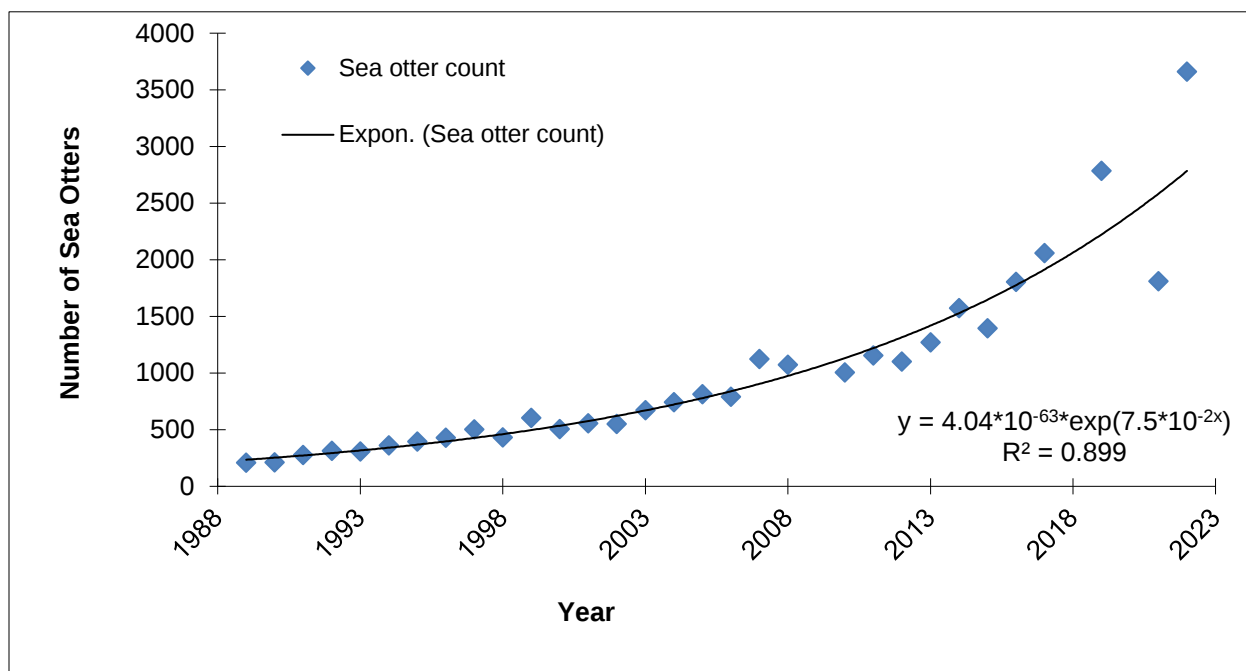


Figure 4. Sea otter counts for Washington State 1989-2022. The solid line depicts an exponential fit for all data 1989 – 2022, with 2022 represented by the partial count of the Washington sea otter range conducted on June 20 2022. Counts include data from the two offshore transects flown at ~2 and ~4 miles from the coast between Destruction Island and Split/Willoughby Rocks that were not surveyed in previous years. The equation and goodness of fit (R^2) for this model is in the bottom right corner.

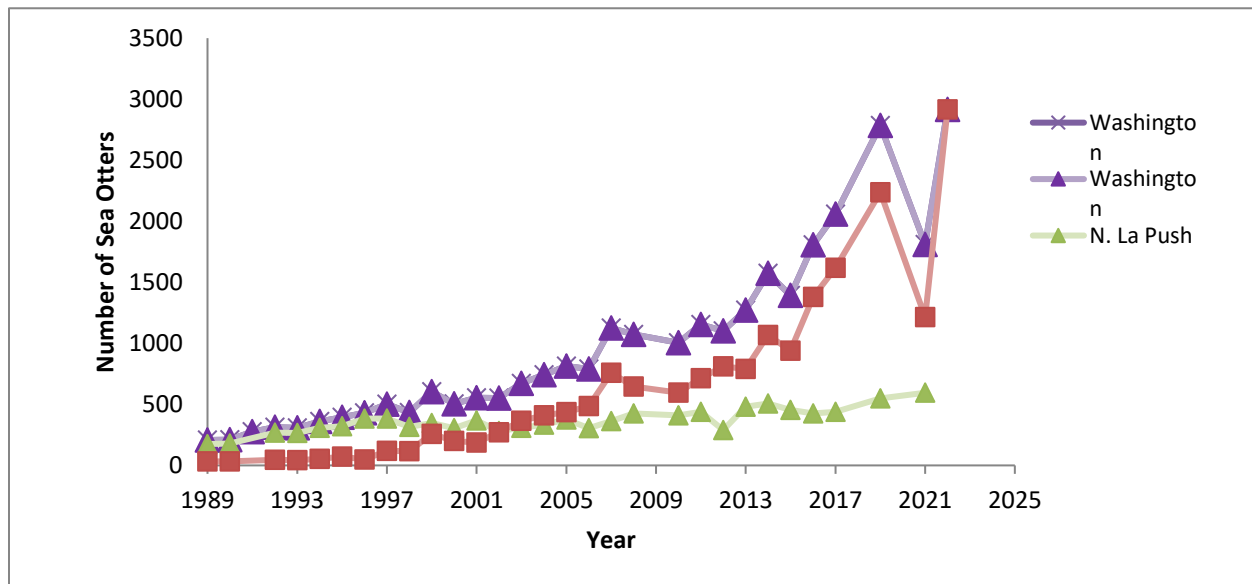


Figure 5. Growth patterns for Washington's sea otter population from 1989 and 2022. Large purple triangles depict the overall count for Washington State. Red squares represent counts for the southern segment (south of La Push) and small green triangles depict counts for the northern segment (north of La Push). Only the counts from the partial survey on June 20, 2022, are presented in this plot, so the overall estimate for Washington and the segment of the sea otter range south of La Push are identical, with no estimate for the area north of La Push in 2022. The 2022 estimate includes counts from two offshore transects flown at ~2 and ~4 miles from the coast between Destruction Island and Split/Willoughby Rocks that were not surveyed in previous years.

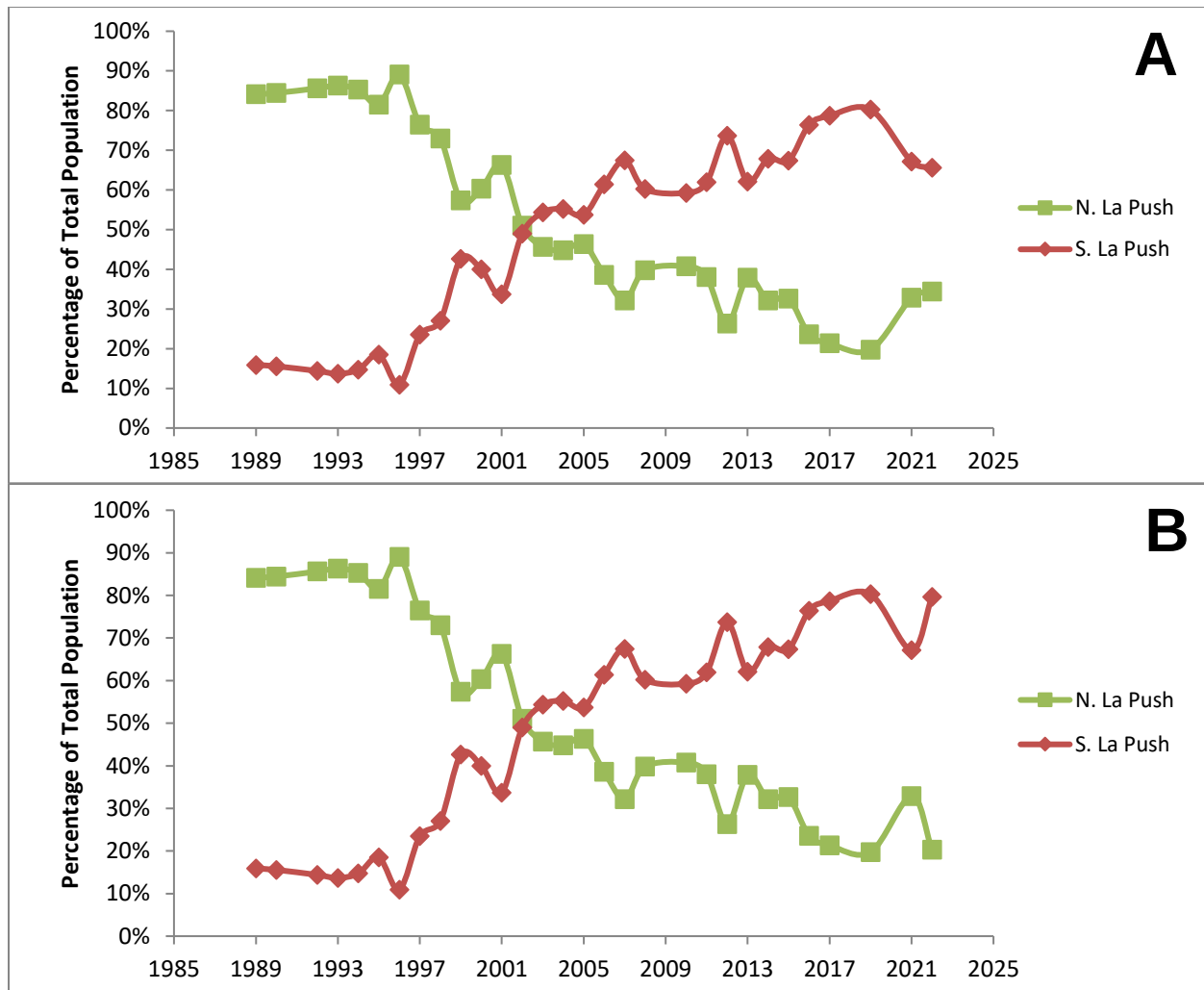


Figure 6. Comparative percentage of Washington sea otter population between the north and south (of La Push, WA) survey segments from 1989-2022. Two scenarios are presented for data from 2022: A) Percentages based on counts from the partial survey conducted on June 20, 2022, and B) percentages based on counts from the partial survey conducted on June 20, 2022, combined with counts of sea otters seen north of La Push on June 23, 2022. Both panels include percentages calculated including counts from two offshore transects flown at ~2 and ~4 miles from the coast between Destruction Island and Split/Willoughby Rocks that were not surveyed in previous years.

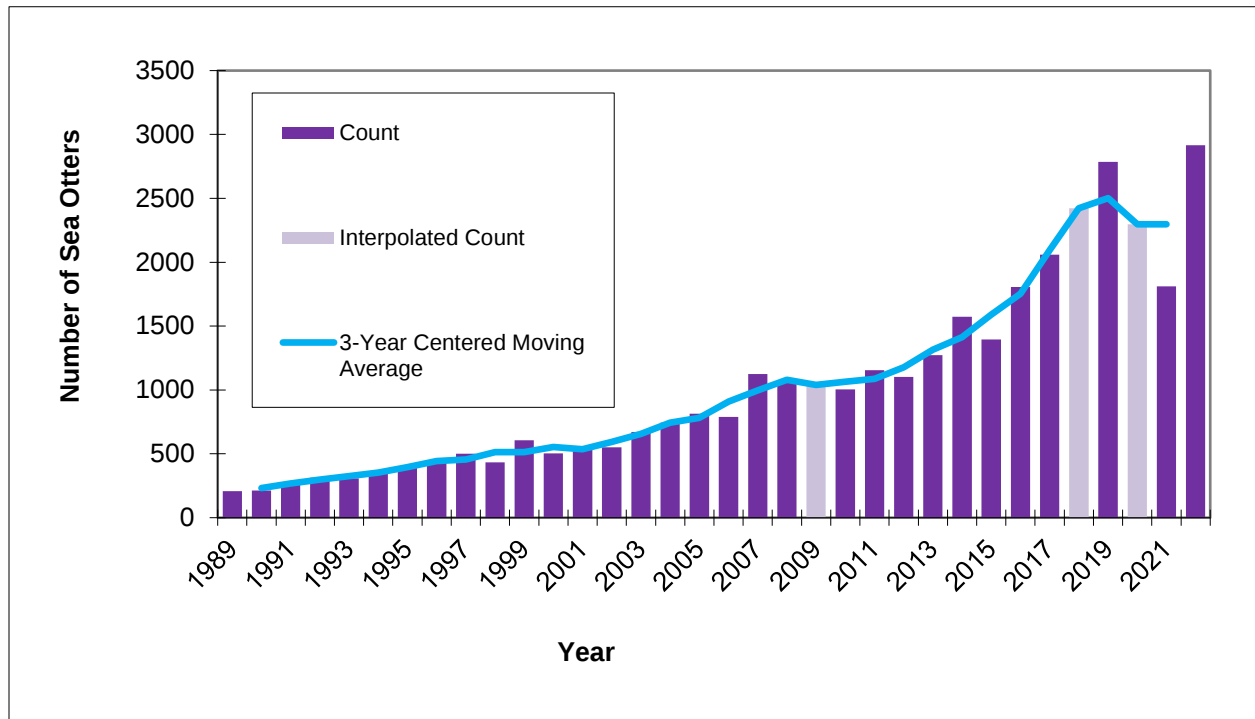


Figure 7. Sea otters rafted in *Macrocystis* kelp bed off Sand Point on June 23, 2022. (Photo: Casey Clark, WDFW)



Figure 8. Sea otter rafted in open water ~4 miles offshore from Raft River, WA on June 20, 2022. (Photo: Casey Clark, WDFW)

Appendix 1.



Supplemental Figure 1. Three year centered moving average of sea otter counts from 1989 to 2022. The moving average is calculated using interpolated data for the years without counts (2009, 2018, 2020). Actual counts of sea otters are represented by the dark purple for the partial survey conducted on June 20, 2022, including counts from two offshore transects flown at ~2 and ~4 miles from the coast between Destruction Island and Split/Willoughby Rocks that were not surveyed in previous years.