Revision of the Critical Habitat Designation for Southern Resident Killer Whales

Final Biological Report
(to accompany the Final Rule)

July 2021

NATIONAL MARINE FISHERIES SERVICE
West Coast Region

Executive Summary

Section 4 of the Endangered Species Act (ESA) requires that, to the maximum extent prudent and determinable, critical habitat be designated for endangered and threatened species based on the best scientific data available. This report contains a biological assessment in support of a revision to the critical habitat designation for the endangered Southern Resident Killer Whale (*Orcinus orca)* Distinct Population Segment (DPS). The revision was prompted by a 2014 petition from the Center for Biological Diversity (CBD) requesting we, the National Marine Fisheries Service (NMFS), revise the existing critical habitat designation by expanding it to include areas of the Pacific Ocean between Cape Flattery, Washington and Point Reyes, California, extending approximately 47 miles (76 km) offshore. The petitioner specified that the three essential physical and biological habitat features NMFS previously identified in the existing critical habitat designation (71 FR 69054; November 29, 2006) are also essential features of the whales' Pacific Ocean habitat. In addition, the petitioner requested we adopt a fourth essential habitat feature for both existing and any proposed expanded critical habitat areas related to in-water sound levels that support communication, prevent hearing loss, and do not result in abandonment of areas (CBD 2014). After requesting public comments on the petition and reviewing the best scientific information available, we announced in a 12-month finding (80 FR 9682, February 24, 2015) that the revision to critical habitat for Southern Resident killer whales was warranted and that we intended to move forward with a proposed rule for critical habitat. We published a proposed rule on September 19, 2019 (84 FR 49214) to designate marine waters between the 6.1 m (20 ft) depth contour and the 200-m (656.2 ft) depth contour from the U.S. international border with Canada south to Point Sur, California, as Southern Resident killer whale critical habitat. We requested public comments through December 18, 2019.

We used the best scientific data and knowledge available to 1) determine the geographical area occupied by the species, 2) identify habitat features essential to the conservation of the species, and 3) delineate specific areas within the geographical area occupied by the species that contain at least one essential habitat feature that may require special management considerations or protection.

Southern Resident killer whales' summer range within inland waters of Washington and British Columbia was previously described in the 2006 critical habitat designation. Land- and vessel-based opportunistic and survey-based visual sightings, satellite tracking, and passive acoustic research conducted since 2006 have provided an updated estimate of the whales' coastal range that extends from the Monterey Bay area in California, north to Chatham Strait in southeast Alaska. In addition, these data have provided a better understanding of the whales' use of these waters, allowing us to identify areas that meet the definition of critical habitat under the ESA. The range of Southern Residents includes coastal and inland waters of British Columbia, Canada, but NMFS cannot designate critical habitat in areas outside of U.S. jurisdiction (50 CFR 424.12(h)), so we are not considering these areas for designation. However, under the Species at Risk Act (SARA), the Government of Canada has designated critical habitat for Southern Resident killer whales in some Canadian inland waters and recently designated a new area in ocean waters on the continental shelf off southwestern Vancouver Island (Fisheries and Oceans

Canada 2018). Some Alaskan waters are considered to be within the geographic area occupied by Southern Resident killer whales, but we are not considering expanding critical habitat to Alaskan waters at this time because there is insufficient information about the whales' distribution, behavior, and habitat use in these areas. For example, there is only one sighting of Southern Residents in Southeast Alaska, in Chatham Strait in 2007. While we can infer that some of the essential habitat features, such as prey, are present to support the whales there, we do not have sufficient data to adequately describe Southern Resident use of habitat features in this area or identify specific areas with those features.

This final biological report identifies the following physical and biological features essential to conservation of Southern Resident killer whales (essential features):

1) Water quality to support growth and development;
2) Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and
3) Passage conditions to allow for migration, resting, and foraging.

These features are consistent with the proposed rule and the features for existing critical habitat. We did not identify in-water sound levels as a separate essential feature of existing or newly designated critical habitat areas. Instead, we will continue our practice of evaluating and managing sound-related effects on the conservation value of Southern Resident killer whale critical habitat. Specifically, we will continue to assess whether and to what extent anthropogenic sound or noise alters the conservation value of the habitat by affecting prey availability or conditions necessary for safe and unrestricted passage, which are already identified as two essential features of existing and newly designated critical habitat for Southern Residents. In addition, we will continue to evaluate and manage direct and indirect effects of anthropogenic noise on individual animals relative to the jeopardy standard in ESA section 7 analyses and through Marine Mammal Protection Act incidental take authorizations.

Within the geographical area occupied, we identified six coastal areas that each contain all three essential features that may require special management consideration or protection. These areas include U.S. ocean waters from Cape Flattery, Washington south to Point Sur, California, between the 6.1-meter and 200-meter depth contours (see Table 1 and Figure 9). NMFS has not identified any unoccupied areas that are essential for the conservation of the species. The following sections discuss this in further detail: Geographical Area Occupied by the Species, Specific Areas, and Unoccupied Areas.

We identified 12 types of human activities that have the potential to affect the habitat features essential to the conservation of Southern Resident killer whales, including (1) salmon fisheries and bycatch; (2) salmon hatcheries; (3) offshore aquaculture/mariculture; (4) alternative energy development; (5) oil spills and response; (6) military activities; (7) vessel traffic; (8) dredging and dredge material disposal; (9) oil and gas exploration and production; (10) mineral mining (including sand and gravel mining); (11) geologic surveys (including seismic surveys); and (12) activities occurring adjacent to or upstream of critical habitat that may affect essential features, that we refer to as "upstream" activities (including activities contributing to point-source water pollution, power plant operations, liquefied natural gas terminals, desalinization plants, and nearshore coastal activities).

Critical habitat designations increase the protections for listed species by bringing awareness to the species' habitat needs and by insuring that federal agency activities are not likely to result in destruction or adverse modification of designated areas. The restriction on destruction and adverse modification of designated critical habitat is specific to federal agencies. The consultation process identified in section 7 of the ESA and outlined in joint NMFS and U.S. Fish and Wildlife regulations (50 CFR 402) establishes a method for avoiding and minimizing impacts to critical habitat. In addition to these identified protections, critical habitat designations may allow for informed natural resource planning for all stakeholders utilizing these areas.

This report summarizes the available data on Southern Resident killer whale presence, distribution, ecological needs, and use of the identified areas as well as NMFS's process for determining these areas as meeting the definition of critical habitat for this endangered DPS. The assessment and findings provided in this report, in conjunction with other agency analyses (e.g., economic analyses), support NMFS' expansion of the areas designated as critical habitat for Southern Resident killer whales.

Table of Contents

List of Figures

List of Tables

List of Acronyms

BOEM	Bureau of Ocean Energy Management
CBD	Center for Biological Diversity
CBNMS	Cordell Bank National Marine Sanctuary
CPS	Coastal pelagic species
DDT	dichlorodiphenyltrichloroethane
DNA	deoxyribonucleic acid
DOD	Department of Defense
DPS	Distinct population segment
EFH	Essential fish habitat
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily significant unit
FERC	Federal Energy Regulatory Commission
FMP	Fishery Management Plan
GFNMS	Greater Farallones National Marine Sanctuary
IMO	International Maritime Organization
LNG	Liquefied natural gas
MBNMS	Monterey Bay National Marine Sanctuary
MMPA	Marine Mammal Protection Act
MOA	Military Operation Area
MPRSA	Marine Protection, Research, and Sanctuaries Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NWFSC	NMFS Northwest Fisheries Science Center
NWTRC	U.S. Navy's Northwest Training Range Complex
NWTT	U.S. Navy's Northwest Training and Testing area
OCNMS	Olympic Coast National Marine Sanctuary
OCS	Outer continental shelf
ODFW	Oregon Department of Fish and Wildlife
OPAREA	Navy's Pacific Northwest Ocean Surface/Subsurface Operating Area

PAH	Polycyclic aromatic hydrocarbons
PBDE	polybrominated diphenyl ethers
PBF	Physical or biological feature
PCB	polychlorinated biphenyls
PCE	Primary constituent element
PFMC	Pacific Fishery Management Council
POP	Persistent organic pollutant
QRS	Quinault Range Site
SRKW	Southern Resident killer whale
TSS	Traffic separation scheme
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife

I. Background

We, the National Marine Fisheries Service (NMFS), listed the Southern Resident killer whale Distinct Population Segment (DPS) as "endangered" under the Endangered Species Act (ESA) in 2005 (70 FR 69903; November 18, 2005) and designated critical habitat for the population in 2006 (71 FR 69054; November 29, 2006). The critical habitat designated in 2006 consists of three areas: (1) the Summer Core Area in Haro Strait and waters around the San Juan Islands, (2) Puget Sound Area, and (3) the Strait of Juan de Fuca Area, which together comprise approximately 2,560 square miles (6,630 sq km) of marine habitat (Figure 1). The 2006 final rule designating critical habitat identifies three habitat features essential to the conservation of the DPS, also known as primary constituent elements[1] (PCEs): (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging.

At the time of the 2006 designation, considerable data were available on the whales' use of the inland waters of Washington, but very little information on the movements of Southern Resident killer whales off the U.S. West Coast existed. Areas of activity of all pods were virtually unknown during their absences from inland waters. In the 30 years prior to the 2006 designation, there had only been 28 sightings in outside waters (including confirmed and unconfirmed sightings off British Columbia, Washington, Oregon, and California through spring of 2004) (Krahn *et al.* 2004). The majority of these sightings were opportunistic, with most occurring within 10 miles (16.1 km) of shore. The offshore range of the animals was also unknown. Since then, an active research effort has been conducted to identify the outer coastal and offshore distribution of Southern Residents.

On January 21, 2014, NMFS received a petition from the Center for Biological Diversity (CBD) to revise critical habitat, citing recent information on the whales' habitat use along the U.S. West Coast (CBD 2014). The CBD requested that NMFS expand the existing critical habitat designation to include areas of the Pacific Ocean between Cape Flattery, Washington, and Point Reyes, California, extending approximately 47 miles (76 km) offshore. The petition stated that because NMFS is continuing to analyze data describing the Southern Residents' use of coastal and offshore waters, the petitioner requested that NMFS "refine this proposal, as necessary, to include additional inhabited zones or to focus specifically on areas of concentrated use." The petition stated that each of the three PCEs (now referred to as "physical or biological features" or "essential features") identified in the 2006 critical habitat designation are also essential features in the whales' Pacific Ocean habitat. In addition, the petitioner requested that we adopt a fourth essential habitat feature for both existing and new critical habitat areas "providing for in-water sound levels that: (1) do not exceed thresholds that inhibit communication or foraging activities,

[1] In 2016, joint U.S. Fish and Wildlife Service (USFWS) and NMFS implemented changes to definitions used for critical habitat determinations (50 CFR 424.02, 81 FR 7414, February 11, 2016). This rule removed the term "primary constituent elements" (or PCEs) from the regulations, and replaced it with a clarified definition for the statutory term "physical or biological features" (or PBFs). When referring to the 2006 critical habitat designation, we will continue to reference PCEs as they are described in 71 FR 69054, November 29, 2006. However, the revised designation will reference the more current terminology, PBFs, as defined in 50 CFR 424.02.

(2) do not result in temporary or permanent hearing loss to whales, and (3) do not result in abandonment of critical habitat areas."

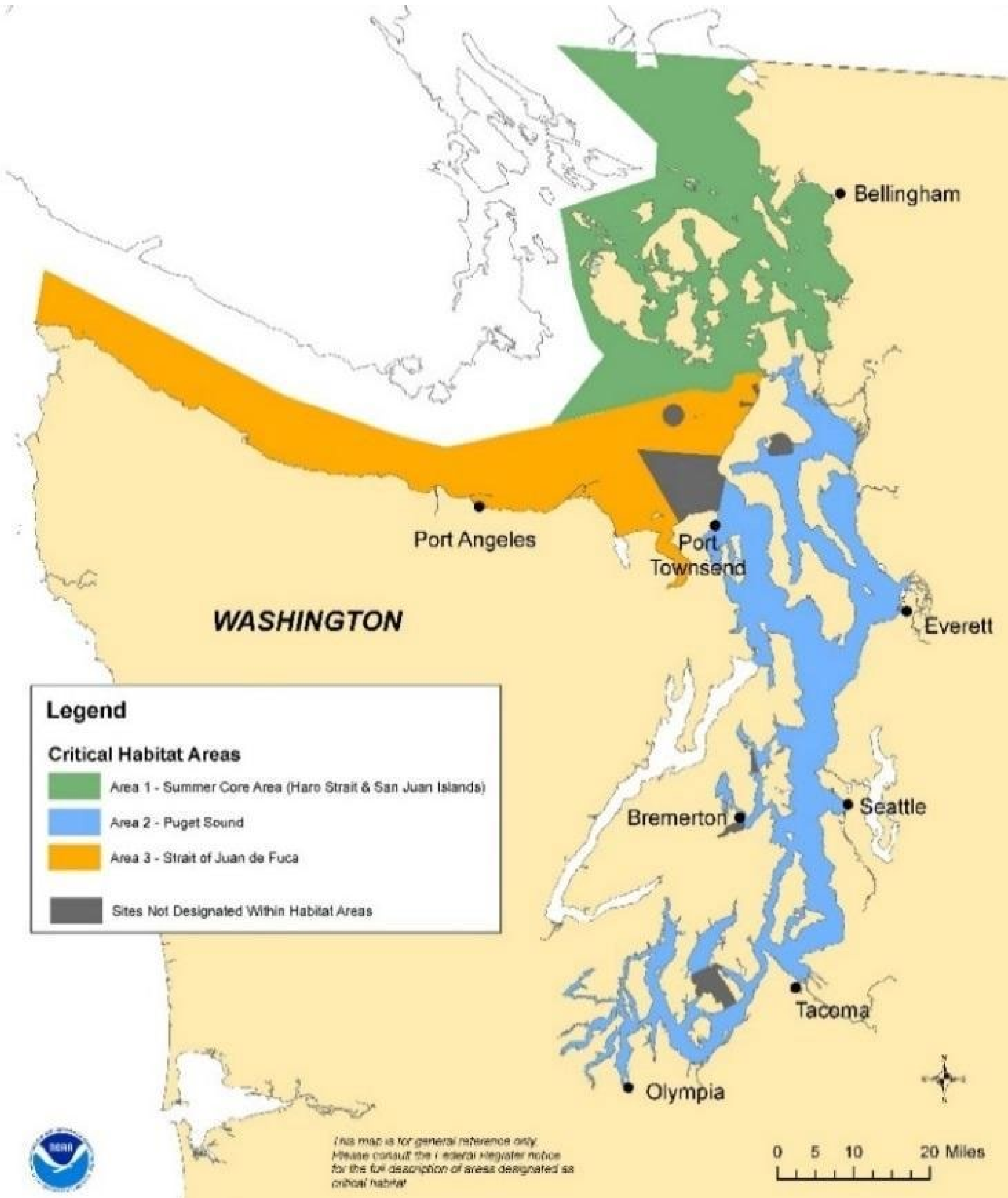


Figure 1. Final Southern Resident killer whale 2006 critical habitat designation. Note: Areas less than 20 feet deep (relative to extreme high water) are not designated as Southern Resident killer whale critical habitat.

We published a 90-day finding on April 25, 2014 (79 FR 22933) that the petition contained substantial information indicating the petitioned action may be warranted. In the finding, we stated that we were initiating a review of the currently designated critical habitat to determine whether revision was warranted, and solicited information from the public to ensure a comprehensive review. Based upon a review of public comments and the available information, we issued a 12-month finding on February 24, 2015 (80 FR 9682) describing our intent to proceed with a revision to critical habitat.

In the 12-month finding, we identified the following steps that we would take to ensure that we use the best available scientific and commercial data to inform any revision and meet the statutory requirements for designating or revising critical habitat:

1. Complete data collection and analysis to refine our understanding of the whales' habitat use and needs;
2. Identify areas meeting the definition of critical habitat, including determining the geographical area occupied by the species at the time of listing; identifying the physical or biological features essential to the conservation of the species; delineating areas within the geographical area occupied by the species that contain these features and that may require special management considerations or protections; and delineating any areas outside of the geographical area occupied by the species that are essential for the conservation of the species;
3. Conduct economic, national security, and other required analyses to inform our consideration of whether any areas identified in Step 2 may be excluded from critical habitat under section 4(b)(2) of the ESA; and
4. Develop a proposed rule for publication in the Federal Register and seek public comment.

We published a proposed rule on September 19, 2019 (84 FR 49214) to designate marine waters between the 6.1 m (20 ft) depth contour and the 200-m (656.2 ft) depth contour from the U.S. international border with Canada south to Point Sur, California, as Southern Resident killer whale critical habitat. We requested public comments through December 18, 2019, and held three public hearings, one each in Santa Cruz, CA, Newport, OR, and Seattle, WA between November 4th, 2019 to November 6th 2019 (84 FR 55530).

This biological report provides the best available information, including analysis as described in Step 1 and identification of areas as described in Step 2. This report summarizes relevant historical information and new information obtained since 2006 including reports and unpublished data from the NMFS Northwest Fisheries Science Center (NWFSC), public comments, and scientific literature regarding killer whale natural history relevant to a revision of critical habitat. Recent relevant research includes work on prey selection and availability, winter distribution and offshore range, vessel impacts and noise, and pollution and contaminants.

A draft biological report was used to inform Steps 3 and 4, conduct the initial 4(b)(2) analysis and publish a proposed rule. Section 4(b)(2) of the ESA requires us to use the best available data in designating critical habitat. It also requires that before we designate any particular area, we must consider the economic impact, impact on national security, and any other relevant impact. Under section 4(b)(2), we also identify the conservation benefits to the species of designating particular habitat areas; areas this biological report will help to identify. After considering public comments on the proposed rule (84 FR 49214) and new information that has become available since publication of the proposed rule, this updated biological report supports the final rule and the final 4(b)(2) analysis.

Information on NMFS science and activities to recover Southern Resident killer whales can be found in a number of publications. A Recovery Plan was completed in 2008 and provides an overview of the threats to the whales and actions needed to recover the DPS (NMFS 2008a). A comprehensive review of killer whale research and regulatory actions over the past decade can be found in NMFS' "Southern Resident Killer Whales - 10 Years of Research and Conservation" (NMFS 2014b). A five-year status review under the ESA completed in December 2016 provides an evaluation of the status of the population and progress toward meeting recovery goals, and concludes that the Southern Resident killer whales should remain listed as endangered (NMFS 2016b). Information on the research program conducted by the NMFS NWFSC can be found at https://www.nwfsc.noaa.gov.

II. Critical Habitat

The ESA defines critical habitat in section 3(5)(A) as:

> "(i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the ESA, in which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and
>
> (ii) specific areas outside the geographical area occupied by the species at the time it is listed upon a determination that such areas are essential for the conservation of the species."

Section 3(3) of the ESA defines "conservation" as the use of all methods and procedures needed to bring the species to the point at which listing under the ESA is no longer necessary.

Section 4(a)(3)(B)(i) of the ESA precludes from designations any lands owned by, controlled by, or designated for the use of the Department of Defense that are covered by an integrated natural resources management plan that the Secretary [of Commerce] has found in writing will benefit the listed species.

Section 4(b)(2) of the ESA requires NMFS to designate critical habitat for threatened and endangered species on the basis of the best scientific data available and after taking into consideration the economic impact, impact on national security, and any other relevant impact, of specifying any particular area as critical habitat. This section grants the Secretary discretion to exclude any particular area from critical habitat if "the benefits of such exclusion outweigh the benefits of specifying such area as part of the critical habitat." The Secretary's discretion is limited, however, as areas may not be excluded if such exclusion will result in the extinction of the species.

The principal benefit of designating critical habitat is that ESA section 7 requires every federal agency to ensure that any action it authorizes, funds, or carries out is not likely to result in the destruction or adverse modification of designated critical habitat. This complements the section 7 provision that federal agencies ensure their actions are not likely to jeopardize the continued existence of a listed species. In some cases, mitigation or management measures may be required to prevent destruction or adverse modification of designated critical habitat. These measures are determined during the section 7 consultation process and are project specific. Modifications of such projects would likely vary from project to project depending on such factors as location, the scope or extent of the project, number and type of essential features potentially affected, or project duration. Also, identifying the geographic location of critical habitat facilitates implementation of section 7(a)(1) of the ESA by identifying areas where Federal agencies can focus their conservation programs and use their authorities to further the purposes of the ESA. Another possible benefit is that the designation of critical habitat can serve to educate the public regarding the potential conservation value of an area.

Activities with no federal nexus are not subject to the section 7 consultation and therefore are not subject to project modifications that might result from section 7 consultation. These include a variety of activities that may occur in waters designated as Southern Resident killer whale critical habitat including common recreational activities such as boating (excluding federal vessel approach regulations) or diving. NMFS places no additional prohibitions or restrictions on areas as a result of designating them as critical habitat; however, non-federal entities may use information from the critical habitat designation to inform and identify actions that may protect and conserve the features that support Southern Resident killer whale critical habitat.

III. Natural History

This section of the report provides background information relevant for understanding habitat use and specific needs of the species. We provide a discussion of the Southern Resident killer whale's natural history, including distribution, population status and trends, reproduction and growth, hearing and vocalizations, foraging and prey, and threats. The discussion focuses on research findings that have become available since the 2006 critical habitat designation.

A. Distribution

Three distinct ecotypes of killer whales, called residents, transients (or Bigg's), and offshores, are recognized in the nearshore waters of the northeastern Pacific Ocean. Although there is considerable overlap in their ranges, these forms display significant genetic differences due to very restricted interchange between member animals (Hoelzel & Dover 1991, Hoelzel *et al.* 1998, Barrett-Lennard 2000, Barrett-Lennard & Ellis 2001, Hoelzel *et al.* 2002, Krahn *et al.* 2004, Morin *et al.* 2010). Important differences in ecology, behavior, morphology, and acoustics also exist, which are derived from the dietary specializations of each ecotype (Baird 2000, Ford *et al.* 2000).

The resident killer whale ecotype in the U.S. are distributed from California to Alaska, and include four communities: Southern, Northern, Southern Alaska, and Western Alaska. In addition, the presence of resident killer whales has been documented off the coast of Russia (Krahn *et al.* 2002, Krahn *et al.* 2004). The most recent marine mammal Stock Assessment Reports, as required under the Marine Mammal Protection Act (MMPA), recognize three stocks of resident killer whales in the Eastern North Pacific (Southern, Northern, and Alaska), but note "[t]he resident-type killer whales encountered in western Alaska possibly belong to groups that are distinct from the groups of resident killer whales in the Gulf of Alaska because no call syllables or call patterns (sequence of syllables) between groups were found to match (Matkin *et al.* 2007)" (Carretta *et al.* 2020, Muto *et al.* 2020).

Resident killer whales exhibit advanced vocal communication and live in highly stable social groupings, or pods, led by matriarchal females. The three pods of the Southern Resident DPS, identified as J, K, and L pods, reside for part of the year in the inland waterways of Washington State and British Columbia known as the Salish Sea (Strait of Georgia, Strait of Juan de Fuca, and Puget Sound), principally during the late spring, summer, and fall (Ford *et al.* 2000, Krahn *et al.* 2002). The whales also occur in outer coastal waters, primarily in winter, off Washington and Vancouver Island, especially in the area between Grays Harbor and the Columbia River and off Westport, WA (Hanson *et al.* 2017, 2018). But have been documented as far south as central California (Black et al. 2001) and as far north as the Southeast Alaska (J. Ford, in Hilborn et al. 2012) (Figure 2) (see discussion in section VI 'Geographical Area Occupied by the Species', below). Although seasonal movements are somewhat predictable, there can be large inter-annual variability in arrival time and days present in inland waters from spring through fall, with late arrivals and fewer days present in recent years (Hanson and Emmons 2010; The Whale Museum unpubl. data). Although less is known about the whales' movements in outer coastal waters than in inland waters, data from satellite tagging, opportunistic sightings, and acoustic recordings indicate that Southern Residents spend nearly all of their time on the continental shelf, within 34 km (21.1 mi) of shore in water less than 200 m (656.2 ft) deep (Hanson *et al.* 2017).

Southern Residents are medium-sized cetaceans requiring relatively consistent food sources to sustain metabolic processes throughout the year. Southern Resident killer whales are salmon specialists and particularly Chinook salmon (Ford *et al.* 1998, Ford and Ellis 2006, Hanson *et al.* 2010, Ford *et al.* 2016). Prey availability changes seasonally, and Southern Residents appear to depend on different prey species and stocks (Hanson *et al.* 2010, Ford *et al.* 2016) that occur in different parts of their habitat throughout the year. The seasonal timing of salmon returns to different river systems likely influences their movements.

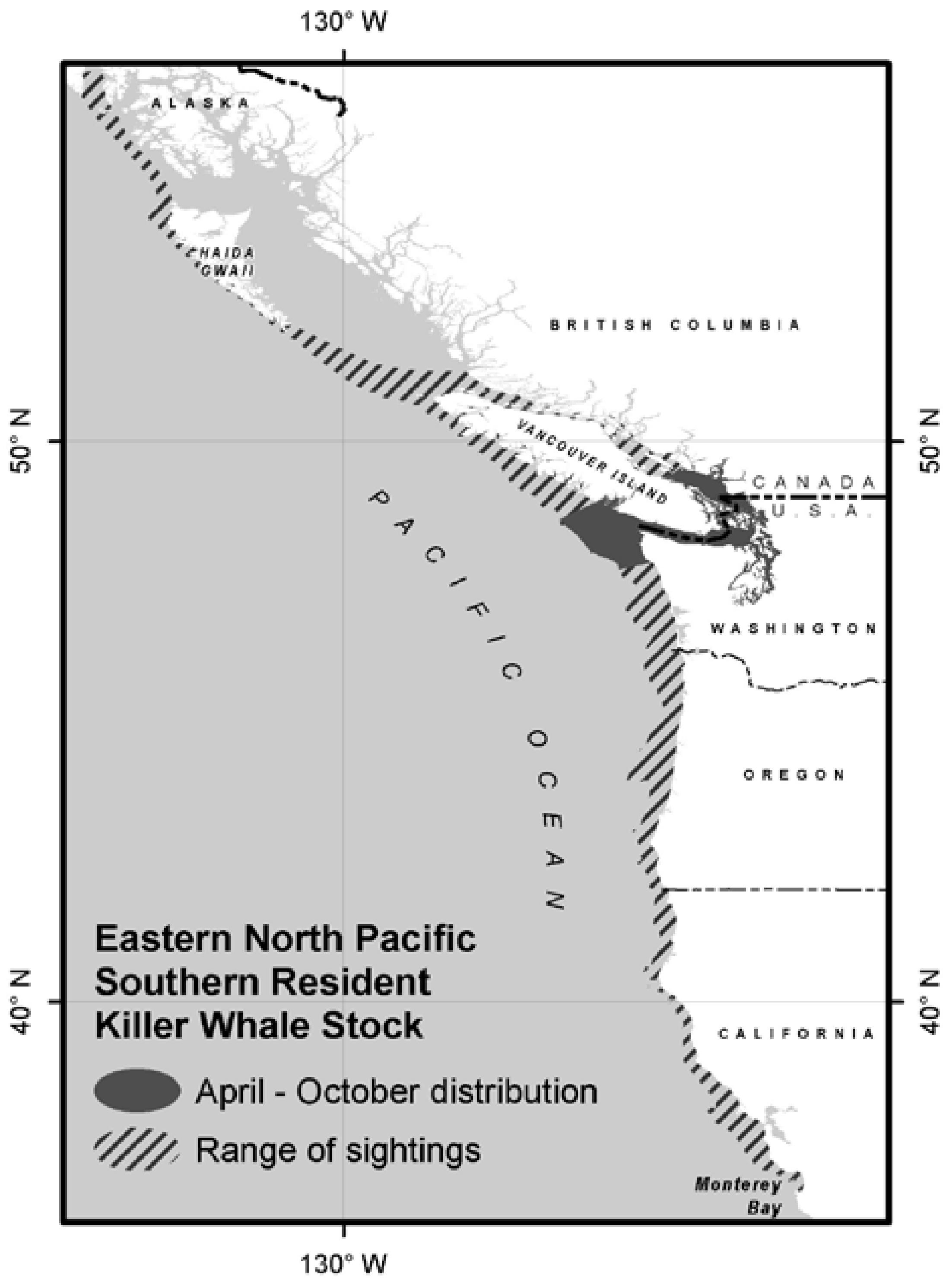


Figure 2. Approximate April–October distribution of Southern Resident killer whales (shaded area) and range of sightings (diagonal lines) (Carretta et al. 2020).

B. Population Status and Trends

The Southern Resident population size has varied over time but is essentially the same size as estimated during the early 1960s (Olesiuk *et al.* 1990, NMFS 2008a) (Figure 3). The population increased through the 1980s and early 1990s following the end of live captures for public display (Olesiuk *et al.* 1990, NMFS 2008a). The population then suffered an almost 20% decline from 1995-2001 (from 98 whales in 1995 to 81 whales in 2001), largely driven by lower survival rates in L pod. The overall decline of the population in the late 1990s coincided with years of low salmon abundance (Ward *et al.* 2009, Ford *et al.* 2010). The overall population grew and was fairly consistent in the early 2000s but has declined over the last several years, from 86 whales in 2010 to 75 in 2018 (Center for Whale Research 2018). Following the 2018 summer census, and as of July 1, 2019, four whales died or were presumed dead and two calves were born. At present, the Southern Resident population has declined to near historically low levels (Figure 3). As of April 2020, the population is 72 whales (one whale is missing and presumed dead since the 2019 summer census), including 22 whales in J pod, 17 whales in K pod, and 33 whales in L pod. Three new calves have been born following the summer census count.

Figure 3. Population size and trend of Southern Resident killer whales, 1960-2020. Data from 1960-1973 (open circles, gray line) are number projections from the matrix model of Olesiuk et al. (1990). Data from 1974-2020 (diamonds, black line) were obtained through photo-identification surveys of the three pods (J, K, and L) in this community and were provided by the Center for Whale Research (unpubl. data) and NMFS (2008a). Data for these years represent the number of whales present at the end of each calendar year.

Despite the fluctuations in population size observed since 1979, recent analysis suggests a downward trend in population growth projected over the next 50 years, in part due to changing age and sex structure of the population, but also related to the relatively low fecundity rate observed between 2011 and 2016 (Figure 4) (NMFS 2016b). The population trend projection is most pessimistic if future fecundity rates are assumed to be similar to those in 2016, and less steep but still declining long-term if an average fecundity rate from 2011-2016 is used for the projections. The projection using 2011 through 2016 fecundity data shows some stability and even a slight increase over the next decade but a decline in later years of the model projection. Using more variable survival and fecundity rates may be more representative than relying on the single poor year of 2016, but this single year scenario provides information on what could happen if poor reproduction continues. (See Ward *et al.* 2013 for background information on Southern Resident killer whale population viability modeling and evaluations of fecundity and survival.) Deviations from the assumptions underlying these projections may lead to more pessimistic or optimistic trajectories. For example, these growth trends assume the ratio of female to male births is 50:50; however, from 2011-2016 new births have been skewed slightly toward males (7 of 11, or 64%, were males), and over the entire time series the proportion of births that are female is closer to 43 to 44%. Birth of even a small number of female calves in the next several years could improve the outlook for the age and sex structure of the population.

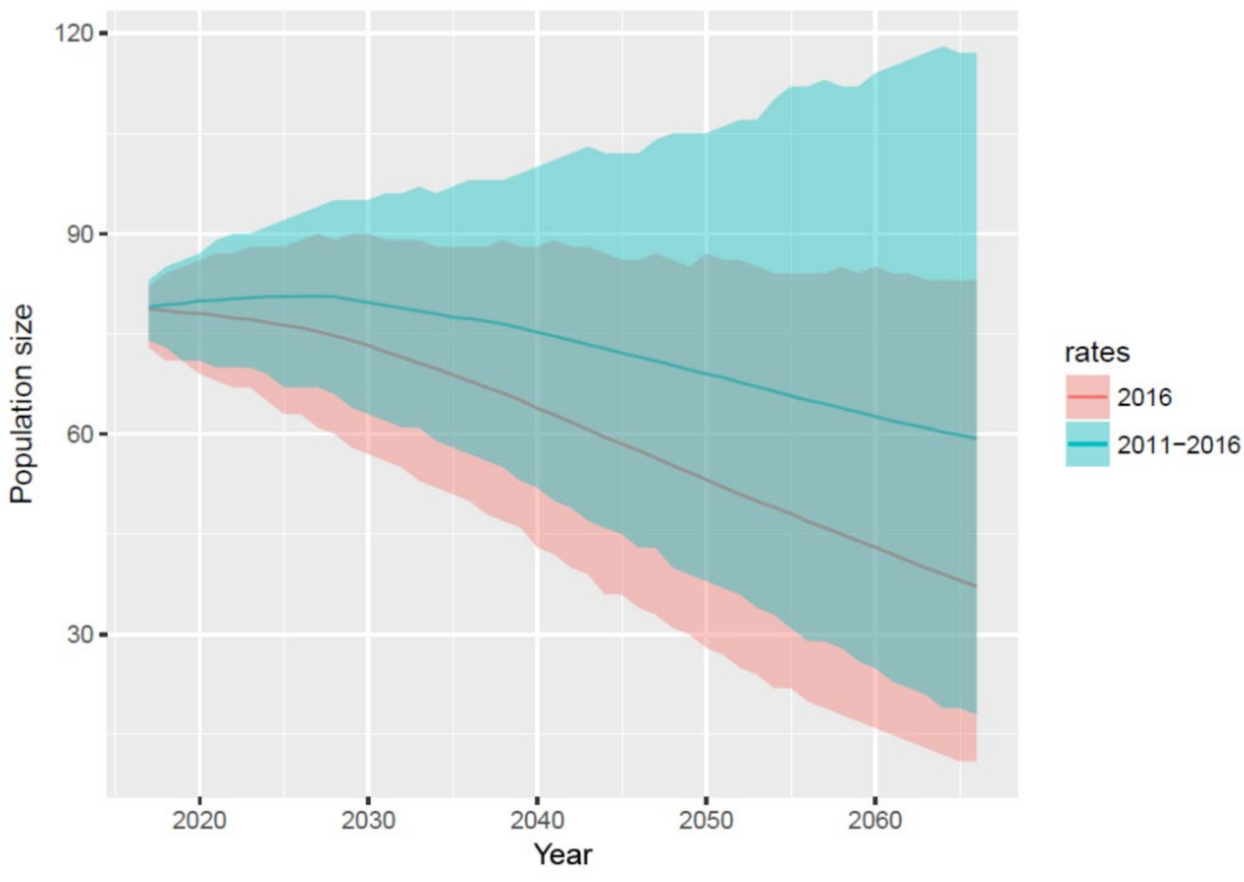


Figure 4. Southern Resident killer whale population size projections from 2016 to 2066 using two scenarios: (1) projections using demographic rates held at 2016 levels, and (2) projections using demographic rates from 2011 to 2016. The pink line represents the projection assuming future rates are similar to those in 2016, whereas the blue represents the scenario with future rates being similar to 2011 to 2016.

C. Reproduction and Growth

Information on reproduction and growth in killer whales comes either from observations of animals held in captivity or from long-term photo-identification studies of the resident whale communities in Washington and British Columbia (Olesiuk *et al.* 1990). Most mating in the North Pacific is believed to occur from May to October (Nishiwaki 1972, Olesiuk *et al.* 1990, Matkin *et al.* 1997), when all three Southern Resident killer whale pods frequent inland waters. However, calves are born in all months, indicating that conception occurs year-round, including during times when the Southern Residents inhabit the outer coast. Mothers and offspring maintain highly stable social bonds throughout their lives and this natal relationship is the basis for the matrilineal social structure (Bigg *et al.* 1990, Baird 2000).

Southern Residents are considered to be reproductively mature between the ages of 10 and 42 years old for both males and females, although males are more likely to become reproductively successful in their late teens or early twenties (Olesiuk *et al.* 2005, Ford *et al.* 2011, Ford *et al.* 2018). Southern Resident females appear to have reduced fecundity compared to the Northern Resident DPS (Ward *et al.* 2013, Vélez-Espino *et al.* 2014); the average inter-birth interval for reproductive Southern Resident females is 6.1 years, which is longer than the estimated 4.88 years for Northern Resident killer whales (Olesiuk *et al.* 2005). Recent evidence has indicated pregnancy hormones (progesterone and testosterone) can be detected in Southern Resident killer whale feces and have indicated several miscarriages, particularly in late pregnancy (Wasser *et al.* 2017).

Recent genetic paternity analyses using single nucleotide polymorphisms and microsatellites indicate that mating within Southern Resident killer whale pods is common and inbreeding is occurring in the population (Ford *et al.* 2018). Four cases of strong inbreeding were detected (two between parent and offspring, one between paternal half-siblings, and one between an uncle and half-niece), and two males (J1 and L41) were inferred to have sired 52% of all sampled progeny born since 1990 (Ford *et al.* 2011, Ford *et al.* 2018). Inbreeding depression, or fitness effects of inbreeding (e.g., lower survival or fecundity), may be a concern for Southern Residents (Ford *et al.* 2018).

D. Hearing and Vocalizations

Vocal communication is particularly advanced in killer whales and is an essential element of the species' complex social structure. Like all dolphins, killer whales produce numerous types of vocalizations that are useful in navigation, communication, and foraging (Dahlheim & Awbrey 1982, Ford 1989, Barrett-Lennard *et al.* 1996, Ford *et al.* 2000, Miller 2002, Miller *et al.* 2004, Saulitis *et al.* 2005). Most calls consist of both low- and high-frequency components (Bain & Dahlheim 1994). The low-frequency component is relatively omnidirectional, with most energy directed forward and to the sides (Schevill & Watkins 1966). A fundamental tone between 250-1,500 Hz and harmonics ranging to about 10 kHz are present in this component. Most of the energy in the high-frequency component is beamed directly ahead of the animal. This component has a fundamental tone between 5-12 kHz and harmonics ranging to over 100 kHz (Bain & Dahlheim 1994).

Killer whales produce three categories of sounds: echolocation clicks, tonal whistles, and pulsed calls (Ford 1989). Clicks are brief pulses of ultrasonic sound given singly or more often in series known as click trains. They are used primarily for navigation and discriminating prey and other objects in the surrounding environment, but are also commonly heard during social interactions and may have a communicative function (Barrett-Lennard *et al.* 1996).

Most whistles are tonal sounds of a fundamental frequency with the addition of several harmonics (Thomsen *et al.* 2001). Whistle structure is stable over time, although gradual minor changes in some whistle types have been detected (Riesch *et al.* 2006). Southern Residents produce whistles for both long-range communication (e.g., during foraging and slow traveling) and social interactions (Riesch *et al.* 2006).

Pulsed calls are the most common type of vocalization in killer whales and resemble squeaks, screams, and squawks to the human ear. Most calls are highly stereotyped and distinctive in structure, being characterized by rapid changes in tone and pulse repetition rate, with some reaching up to 4,000 or more pulses per second (Jehl *et al.* 1980, Ford 1989). Three categories of pulsed calls are distinguishable: discrete, variable, and aberrant (Ford 1989). Discrete calls have received considerable study and are especially noteworthy because they are used repetitively and have stable group-specific structural traits. Discrete calls are the predominant sound type during foraging and traveling, and are used for maintaining acoustic contact with other group members, especially those out of visual range (Ford 1989, Ford *et al.* 2000, Miller 2002). Variable and aberrant calls are given more frequently after animals join together and interact socially.

As with other delphinids, killer whales hear sounds through the lower jaw and other portions of the head, which transmit the sound signals to receptor cells in the middle and inner ears (Møhl *et al.* 1999, Au 2002). Killer whales are considered mid-frequency cetaceans (NMFS 2018a). Their hearing ability extends from approximately 600 Hz to 114 kHz, but is most sensitive in the range of 5-81 kHz (Branstetter *et al.* 2017).

E. Foraging and Prey

Southern Resident killer whales are known to consume a variety of fish species (22) and at least one species of squid (Ford *et al.* 1998, Ford *et al.* 2000, Ford & Ellis 2006, Hanson *et al.* 2010, Ford *et al.* 2016), based on fish scales and tissue remains collected from predation events, fecal sampling, and stomach contents studies. This work suggests an overall preference for Chinook salmon (*Oncorhynchus tshawytscha)* during the summer and fall. However, Chum (*O. keta)*, coho (*O. kisutch)*, and steelhead (*O. mykiss*) are a substantial component of the Southern Resident killer whale diet during the late summer and fall. Rockfish (*Sebastes* spp.), Pacific halibut (*Hippoglossus stenolepis*), and Pacific herring (*Clupea pallasi*) were also observed during predation events (Ford & Ellis 2006), however, these data may underestimate the extent of feeding on bottom fish (Baird 2000). A number of smaller flatfish, lingcod (*Ophiodon elongatus*), greenling (*Hexagrammos* spp.), and squid have been identified in stomach content analysis of resident whales (Ford *et al.* 1998). Despite J pod utilizing much of the Salish Sea—including the Strait of Georgia—in winter months (Hanson et al. 2018), few diet samples have been collected in this region in winter. Additionally, limited data have been collected on coastal diet, though recent data indicate that salmon, particularly Chinook, remains an important dietary component when the Southern Resident killer whales occur in outer coastal waters during winter and spring (Hanson *et al.* 2021, discussed in detail below).

Southern Residents are the subject of ongoing research, including direct observation, scale and tissue sampling of prey remains, and fecal sampling. The diet data indicate that the whales are consuming mostly older (ages 3-5) Chinook salmon (Hanson *et al.* 2021). Chinook salmon is their primary prey despite the much lower abundance of Chinook salmon in some areas and during certain time periods compared to other salmonids (Ford and Ellis 2006). Factors that might influence this preference include Chinook salmon's large size, high fat and energy content, and year-round occurrence in the whales' geographic range (Ford and Ellis 2006). Chinook salmon have the highest value of total energy content compared to other salmonids because of their larger body size and higher energy density (kcal/kg) (O'Neill *et al.* 2014). Research suggests that killer whales are capable of detecting, localizing, and recognizing Chinook salmon through their ability to distinguish Chinook salmon echo structure as different from other salmon (Au *et al.* 2010).

Fecal DNA analysis has revealed that greater than 98% of Southern Resident killer whale diet in inland waters is made up of salmonids, with Chinook comprising 79.5% of the overall summer diet (Ford *et al.* 2016). This confirms previous studies that used visual observations of foraging events and collection of prey remains to identify prey items (Hanson *et al.* 2010). Fecal DNA analysis also found that coho salmon make up as much as 15% of the summer diet, with increased consumption of coho salmon (more than 40% of the diet) in late summer during seasonal downward shifts in Chinook salmon abundance. Consumption of chum salmon increases in the fall in Puget Sound, suggesting that Southern Residents are capable of switching to different prey items in the absence of Chinook (Hilborn *et al.* 2012, Ford *et al.* 2016). Recent prey and fecal samples taken from inland waters continue to support these general seasonal patterns in diet (Hanson *et al.* 2021).

Genetic identification methods have been used to estimate the river of origin of Chinook salmon consumed by the whales. Genetic analysis of the Hanson *et al.* (2010) samples indicate that when Southern Residents are in inland waters from May to September, they consume Chinook salmon stocks that originate from regions including the Fraser River (including Upper Fraser, Mid Fraser, Lower Fraser, North Thompson, South Thompson and Lower Thompson), Puget Sound (North and South Puget Sound), the Central British Columbia Coast and West and East Vancouver Island. Stock identification also showed a high likelihood that the whales consume hatchery fish, indicating that hatcheries could be making important contributions to Southern Resident recovery (Hanson *et al.* 2010). Recent data suggests salmon consumed by Southern Residents in Puget Sound can originate from other sources as well including as far North as the Skeena River in Canada and one sample from as far South as the California Central Valley (Hanson *et al.* 2021).

Fewer predation events have been observed and fecal samples collected from Southern Residents off the Pacific coast, but recent data from winter months in this region indicate that salmon, and Chinook salmon in particular, remains an important dietary component when the whales occur in outer coastal waters (Hanson *et al.* 2021). Prior to 2013, only three prey samples for Southern Residents on the U.S. outer coast had been collected (NWFSC unpubl. data). From 2013 to 2016, satellite tags were used to locate and follow the whales to obtain predation and fecal samples.

Samples were collected from northern California to northern Washington (Figure 5). Results of 57 coastal prey sample items indicate that, as is the case in inland waters, Chinook salmon are the primary species consumed on the outer coast, although steelhead, chum, and Pacific halibut were also consumed. Quantitative analyses of diet from fecal samples also indicate a high proportion of Chinook in the diet of whales feeding in waters off the coast but a greater diversity of species, of which lingcod, halibut, and steelhead also comprised a substantial portion of the diet (Hanson *et al.* 2021). Foraging on chum and coho salmon, steelhead, Big skate (*Rana binoculata*) and lingcod was also detected in recent fecal samples (Hanson *et al.* 2021). Most of the Chinook prey samples from coastal waters were determined to have originated from the Columbia River basin, including Lower Columbia Springs, Middle Columbia Tule, Upper Columbia Summer/Fall. However, the Chinook salmon stocks that were identified in coastal samples also included fish from as far north as the Taku River in Alaska and as far south as the Central Valley California (Hanson *et al.* 2021). Thirty of the Chinook samples collected off the outer coast could be aged, with the age four age class being the most numerous (60%), followed by ages five (26.7%) and three (13.3%) (Hanson *et al.* 2021). In both inland and outer coastal waters, Southern Resident killer whales generally consumed salmon that were younger than those consumed by Northern Resident killer whales (Ford & Ellis 2006, Hanson *et al.* 2021).

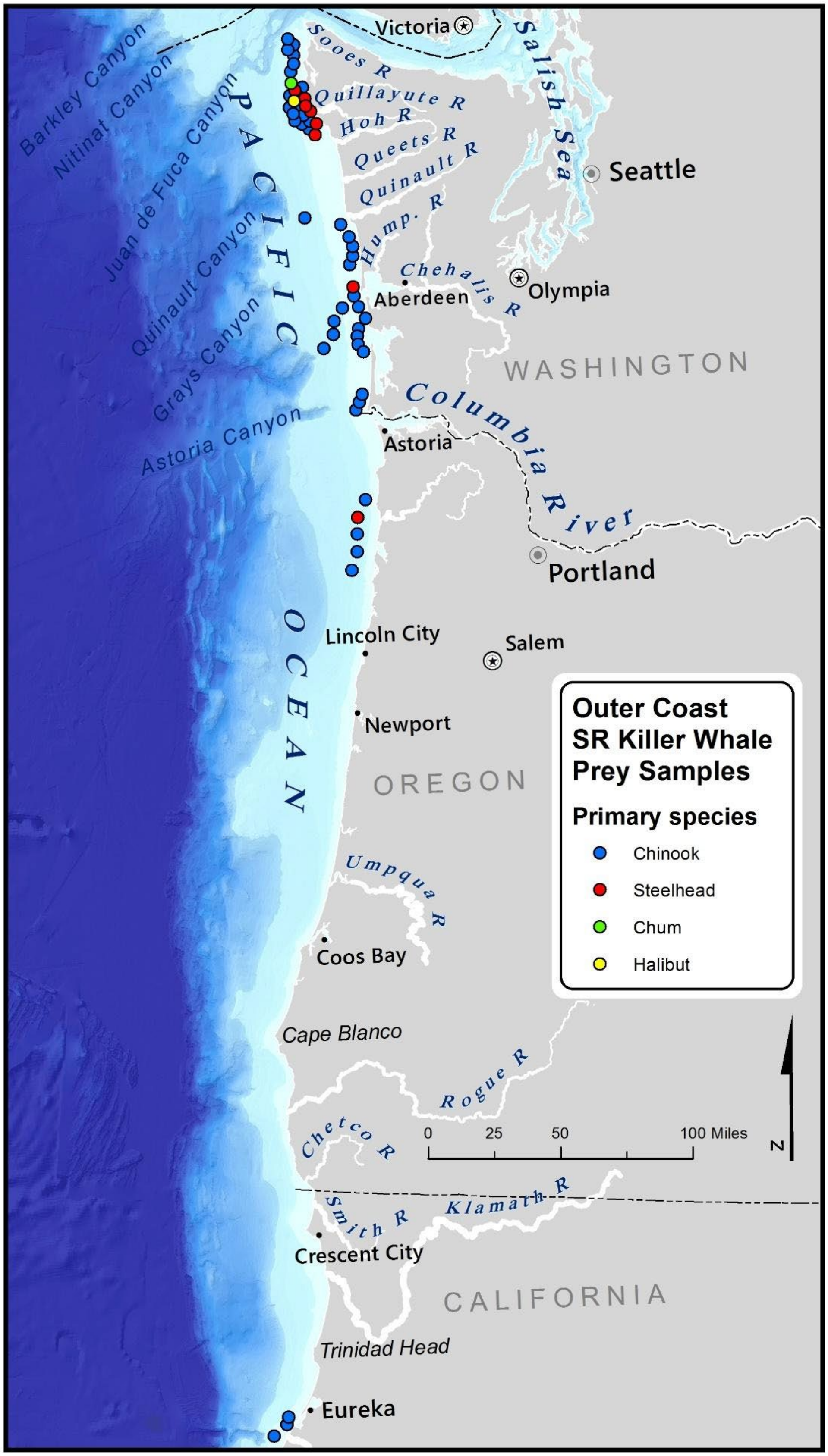

Outer Coast
SR Killer Whale
Prey Samples
Primary species
Chinook
Steelhead
Chum
Halibut
Victoria
Salish Sea
Seattle
Olympia
Aberdeen
Astoria
Portland
Salem
Lincoln City
Newport
Coos Bay
Cape Blanco
Crescent City
Trinidad Head
Eureka
WASHINGTON
OREGON
CALIFORNIA
PACIFIC OCEAN
Sooes R
Quillayute R
Hoh R
Queets R
Quinault R
Hump. R
Chehalis R
Columbia River
Umpqua R
Rogue R
Chetco R
Smith R
Klamath R
Barkley Canyon
Nitinat Canyon
Juan de Fuca Canyon
Quinault Canyon
Grays Canyon
Astoria Canyon
0 25 50 100 Miles
N

Figure 5. Location and species for scale/tissue samples collected from Southern Resident killer whale predation events in outer coastal waters (see Hanson et al. 2021).

NMFS and the Washington Department of Fish and Wildlife (WDFW) recently developed a prioritized list of West Coast Chinook salmon stocks that are important to the recovery of Southern Resident killer whales (NMFS & WDFW 2018). The list is based on a model that analyzes how much the whales likely depend on different stocks. The model weighs salmon stocks based on how much their ranges overlap with the Southern Residents, and incorporates the latest research identifying which salmon stocks the killer whales eat based on prey and fecal samples. The model gives extra weight to salmon runs that support the Southern Residents when their access to food is limited. The first 15 salmon stocks on the priority list include fall, spring, and summer Chinook salmon runs in rivers spanning from British Columbia to California, including the Fraser, Columbia, Snake, and Sacramento Rivers, as well as several rivers in Puget Sound watersheds (NMFS & WDFW 2018). The diversity of rivers reflect the variety of salmon stocks the whales encounter during their winter forays along the West Coast and during the summer months when they frequent the inland waters of the Salish Sea. Identifying priority salmon stocks for the whales will help NMFS and partners target recovery actions for salmon runs that are critical to recovering the Southern Residents, to provide the greatest benefit to both native West Coast salmon and the Southern Residents.

Killer whales detect their prey through a combination of echolocation and passive listening (Barrett-Lennard *et al.* 1996), and likely use vision and echolocation during prey capture. Captive killer whales consume about 3.6-4% of their body weight daily (Sergeant 1969, Kastelein *et al.* 2003). Food intake in captive animals gradually increases from birth until about 20 years of age (Kriete 1995, Kastelein *et al.* 2003). Food consumption has also been noted to increase among captive females late in pregnancy or during lactation (Kriete 1995, Kastelein *et al.* 2003). Due to their greater activity levels, wild killer whales presumably have greater food demands than captive individuals (Kastelein *et al.* 2003). Noren (2011) estimated the daily prey energy requirements for Southern Resident killer whales, which vary by age class and sex. Noren (2011) estimated that immature whales between 1 and 6 years of age require 41,376 to 130,246 kcal per day, while juveniles from 7 to 12 years of age bneed 118,019 to 174,380 kcal per day. Females older than 12 years require 149,972 to 217,775 kcal per day, while males over 12 years require 155,885 to 269,458 kcal per day (Noren 2011). Southern Residents' preferred prey, Chinook salmon, is larger and has a higher total energy content (average 13,409 kcal per fish; O'Neill *et al.* 2014) when compared to other salmon species found in the region. It would take roughly 2.7 coho, 3.1 chum, 3.1 sockeye, or 6.4 pink salmon to obtain the same amount of energy as can be found in one Chinook salmon (O'Neill *et al.* 2014). However, the total energy varies significantly among Chinook salmon populations, due to variation in body size and lipid content. For example, mature Puget Sound Chinook salmon have relatively low mean total energy values (8,941 kcal per fish), whereas Chinook salmon returning to the Sacramento River have a mean total energy above 15,000 kcal per fish (O'Neill *et al.* 2014).

F. Threats

F.1. Prey availability

There are multiple lines of evidence of poor body condition in Southern Residents (Durban *et al.* 2009, Fearnbach *et al.* 2011, Matkin *et al.* 2017, Fearnbach *et al.* 2018) and how the Southern

Residents may be affected by limitations of the primary prey, Chinook salmon (NMFS 2016b, Wasser *et al.* 2017) (NMFS recently reviewed this evidence in our biological opinions on fisheries conducted under the PFMC Salmon Fishery Management Plan for Southern Resident Killer Whales (NMFS 2020a, 2021b). Several studies in the past have identified correlations or connections between Chinook salmon abundance indices and Southern Resident killer whale survival, social cohesion, growth rate, and fecundity (Ward et al. 2009, Ford et al. 2010, Fearnbach et al. 2011, Ward et al. 2013). In recent years, the relationship between Chinook salmon abundance and Southern Resident killer whale demographic rates have weakened (e.g. Southern Resident status continues to decline with varying levels of Chinook abundance) and uncertainty remains due to several challenges in quantitatively characterizing the relationship between Southern Residents and Chinook salmon (NMFS 2020a, 2021b; Pacific Fishery Management Council 2020a), which we discuss in detail below (see section V.B.2).

Recent studies utilizing aerial photogrammetry methods to study body condition are useful in the study of individual and population-wide health and have documented whales in poor condition, some of which have disappeared from the population (Durban *et al.* 2009, Fearnbach *et al.* 2011, Fearnbach *et al.* 2018). Additional studies of the health status and body condition of the whales and distribution of their prey in different seasons are underway and may help clarify where and when the whales may be food limited, and what other factors may contribute to the observations by Fearnbach *et al.* (2011) and Durban *et al.* (2009).

Researchers have also used fecal samples to evaluate the health of Southern Residents. Specifically, these researchers used hormone measures of stress (glucocorticoids, or GCs), nutrition (triiodothyronine, or T3), and reproductive status (progesterone, or P4, and testosterone, or T) in feces to determine the physiological impacts of nutritional and psychological stress, presumably caused by vessel disturbance and lack of prey (Ayres *et al.* 2012, Wasser *et al.* 2017). These studies have shown variable T3 values in Southern Residents during late spring and summer, which the authors suggest may indicate nutritional stress during the period spent in the Salish Sea. Elevated T3 values in the early spring when the whales first arrive in the area, however, indicated that the whales are foraging on prey with high nutritional value before they get there, suggesting the importance of the coastal early spring Columbia River Chinook salmon run (Ayres *et al.* 2012, Wasser *et al.* 2017). Some modeling efforts from Wasser *et al.* (2017) also suggest that nutritional stress plays an important role in reproductive success. However, a lack of data from winter months and understanding of variability in the data limits the utility of this information and makes it difficult to assess the overall nutritional status of the whales based on these values alone (Hilborn *et al.* 2012).

In addition to the physiological effects of reduced prey abundance that have been observed in Southern Residents, there is also evidence of a negative impact on social cohesion when salmon abundance is low (Parsons *et al.* 2009, Foster *et al.* 2012). Social cohesion likely plays an important role in Southern Resident survival, growth, and reproduction. When prey abundance is low, whales must spread out to find food and dedicate more of their time to foraging rather than on social interactions such as reproduction and information transmission (Foster *et al.* 2012). Researchers have observed a correlation between reduced reproduction in Southern Residents and low salmon abundance (Ford *et al.* 2010), although this correlation is weaker in recent years than it was in the past (see paragraph above). So it is unclear to what extent the interruption of social cohesion as a result of reduced salmon abundance may impact the population or limit recovery.

F.2. Contaminants

Since research on the effects of environmental contaminants on Southern Residents began in the early 1990s, it has been widely known that persistent organic pollutants (POPs) or "legacy contaminants" are of particular concern to the whales. Whales become exposed to POPs through their prey as well as through nursing, when adult females offload the contaminants stored in their blubber as it is metabolized to produce milk, which then carries those contaminants to the offspring. High contaminant levels may exacerbate the effects of reduced prey abundance as the contaminants become mobilized in the blood stream when stored fat is metabolized in the absence of food. High concentrations of POPs have been linked to endocrine, metabolic, and immune disruption, cancer, decreased reproduction, and increased calf mortality in marine mammals (Reijnders 1986, de Swart *et al.* 1996, Schwacke *et al.* 2002, Ylitalo *et al.* 2005, Buckman *et al.* 2011, Gockel & Mongillo 2013, Hall *et al.* 2018) and POPs have been detected in killer whales including Southern Residents (Lundin *et al.* 2016, Mongillo *et al.* 2016).

Three main contaminants of concern are polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and dichlorodiphenyltrichloroethane (DDTs), although others do exist and are being studied. PCB levels have been detected in Southern Resident killer whale blubber samples at concentrations that far exceed the threshold known to have detrimental health effects on harbor seals in Puget Sound. Recent biopsies indicate that the concentration of PCBs in male killer whales has decreased since the 1990s, likely as a result of decreased exposure due to regulations banning their production in the U.S. beginning in 1979 (Ross *et al.* 2000, Krahn *et al.* 2007). However, PCBs continue to be a concern for killer whales worldwide (Desforges *et al.* 2018). PBDEs have also been detected at relatively high levels in the whales' blubber. PBDEs have been used in many common household items such as flame retardants since the 1970s, and although banned in both the United States and Canada, they are still prevalent in many products made before 2004. However, based on declining concentrations found in other species and their discontinued production in the U.S. and Canada, the accumulation of PBDEs in Southern Residents is expected to slow in similar fashion to PCBs (Elliott *et al.* 2005, Law *et al.* 2010, West *et al.* 2011, Ross *et al.* 2013, Mongillo *et al.* 2016). High levels of DDTs have also been found in the whales, especially in K and L pods, which spend more time in California in the winter where DDTs still persist in the marine ecosystem (Sericano *et al.* 2014). The effects of these three legacy contaminants cannot be considered in isolation, as synergistic, additive, or antagonistic effects may shape their impacts on whale health. Furthermore, chemical byproducts or metabolites of these POPs are also worth studying, as they may further increase toxicity or result in their own impacts not otherwise identified (Mongillo *et al.* 2016).

Although our understanding of contaminant loading in killer whales has grown significantly since Southern Residents were listed, there is still not enough data to support the establishment of an effects threshold. Future studies should continue to focus on correlating physiological stress with contaminant loads to provide evidence for the health effects of POPs on Southern Residents (Ayres *et al.* 2012, Gockel & Mongillo 2013, Lundin *et al.* 2016).

F.3. Oil spills

Exposure to petroleum hydrocarbons released into the marine environment via oil spills and other discharge sources represents a serious potential health risk for Southern Residents. Polycyclic aromatic hydrocarbons (PAHs), a component of oil (crude and refined) and motor exhaust, are a group of compounds known to be carcinogenic and mutagenic (Pashin & Bakhitova 1979). Exposure can occur through five known pathways: contact, adhesion, inhalation, dermal contact, direct ingestion, and ingestion through contaminated prey (Rosenberger *et al.* 2017). Cetaceans have a thickened epidermis that reduces the likelihood of petroleum toxicity from skin contact with oiled waters (Geraci 1990, O'Shea & Aguilar 2001). Inhalation of vapors at the water's surface and ingestion of hydrocarbons during feeding are more likely pathways of exposure. While marine mammals are generally able to metabolize and excrete limited amounts of hydrocarbons, acute or chronic exposure poses greater toxicological risks (Grant & Ross 2002). Matkin *et al.* (2008) reported that killer whales did not attempt to avoid oil-sheened waters following the *Exxon Valdez* oil spill in Alaska. Observations of Northern Resident killer whales near a more localized spill in Robson Bight at the western end of Johnstone Strait, British Columbia, support those findings (Canadian Press 2007, Williams *et al.* 2009b).

In marine mammals, acute exposure to petroleum products can cause changes in behavior and reduced activity, inflammation of the mucous membranes, lung congestion, pneumonia, liver disorders, and neurological damage (Geraci & St. Aubin 1990). Following the Deepwater Horizon oil spill, substantial research effort has occurred to document adverse health effects and mortality in cetaceans in the Gulf of Mexico. Common bottlenose dolphins (*Tursiops truncatus*) in Barataria Bay, an area that had prolonged and severe contamination from the Deepwater Horizon oil spill, were found to have health effects consistent with adrenal toxicity and increased lung disease (Schwacke *et al.* 2013, Venn-Watson *et al.* 2015), low reproductive success rates (Kellar *et al.* 2017), and changes in immune function (de Guise *et al.* 2017). Previous PAH exposure estimates suggested Southern Residents can be occasionally exposed to concerning levels (Lachmuth *et al.* 2011). More recently, Lundin *et al.* (2018) measured PAHs in whale fecal samples collected in inland waters of Washington between 2010 and 2013 and found low concentrations of the measured PAHs (<10 ppb, wet weight). However, PAHs were as high as 104 ppb in the first year of their study (2010) compared to the subsequent years. Although it is unclear if it was the cause of this trend, higher levels were observed prior to the 2011 vessel regulations that increased the distance vessels could approach the whales.

Some of these impacts can result in population-level consequences that may take decades to recover from (Deepwater Horizon Natural Resource Damage Assessment Trustees 2016). Oil spills are also potentially destructive to prey populations and therefore may adversely affect Southern Residents by reducing food availability. One study evaluating the impacts of a potential oil spill on marine mammals in coastal waters of British Columbia characterized Northern and Southern Resident killer whales as being among the most vulnerable due to their small population sizes, strong site fidelity to areas with high oil spill risk, large group size, late reproductive maturity, low reproductive rate, and specialized diet, among other attributes (Jarvela-Rosenberger *et al.* 2017).

NMFS is working closely with partners including WDFW, the Region 10 Regional Response Team, and the Northwest Area Committee to address the threat of an oil spill in the killer whales' habitat. A killer whale-specific oil spill response plan was adopted as part of the Northwest Area Contingency Plan (USCG *et al.* 2018). NMFS is continuing to work with WDFW to develop specific implementation strategies for the hazing techniques identified in the plan.

F.4. Vessel impacts and sound

Although the long-term effects of behavioral responses from vessel interactions are not well known, it is well documented that resident killer whales respond to vessels engaged in close proximity with short-term behavioral changes (Kruse 1991, Kriete 2002, Williams *et al.* 2002a, Williams *et al.* 2002b, Foote *et al.* 2004, Bain *et al.* 2006, Williams *et al.* 2006, Lusseau *et al.* 2009, Noren *et al.* 2009, Williams *et al.* 2009a, Wieland *et al.* 2010, Senigaglia *et al.* 2016). These observed behavioral changes have included faster swimming speeds (Williams *et al.* 2002b), less directed swimming paths (Williams *et al.* 2002b, Bain *et al.* 2006, Williams *et al.* 2009a), and less time foraging (Bain *et al.* 2006, Williams *et al.* 2006, Lusseau *et al.* 2009, Giles & Cendak 2010, Senigaglia *et al.* 2016). Vessels in the path of the whales can also interfere with important social behaviors such as prey sharing (Ford & Ellis 2006) or nursing (Kriete 2007). With the disruption of feeding behavior that has been observed, it is estimated that the presence of vessels could result in an 18% decrease in energy intake, a consequence that could have a significant negative effect on an already prey-limited species (Williams *et al.* 2006, Lusseau *et al.* 2009).

Previous research results indicate that short-term behavioral changes observed in killer whales can occur with high boat densities and at varying distances of the vessels, ranging from vessel approaches within 100 meters (109.4 yards) to vessels at 400 meters (437.4 yards) or greater distances (Williams *et al.* 2002b, Bain *et al.* 2006, Lusseau *et al.* 2009, Noren *et al.* 2009, Williams *et al.* 2009a, Giles & Cendak 2010). Behavioral changes have also been observed in the presence of different types of vessels. For example, changes in behavior of dolphins and killer whales have been documented in the presence of both motorized and non-motorized vessels (Nichols *et al.* 2001, Lusseau 2003, Trites *et al.* 2007, Noren *et al.* 2009, Williams *et al.* 2010). Northern Residents in particular, a suitable proxy population for Southern Residents, significantly alter their movements and spend less time foraging in the presence of motorized vessels and more time traveling in the presence of kayaks, indicating that the physical presence of vessels, in addition to vessel sound, has an impact on the whales (Williams *et al.* 2010).

In addition to the behavioral changes resulting from the presence of vessels, vessel sounds may also have some negative consequences for Southern Residents. Broadband noise radiated by vessels overlaps with the whales' hearing and vocalization frequencies. Large ships can increase noise above ambient levels at both low (100- 1,000 Hz) and high frequencies (10-96 kHz), including the higher frequencies Southern Resident killer whales use for communication and echolocation (Veirs *et al.* 2016). Noise from vessels may mask or partially or completely prevent the perception of clicks, calls, and whistles made by killer whales, including echolocation used to locate prey and other signals the whales rely on for communication and navigation. Masking of echolocation would reduce foraging efficiency (Holt 2008). Increased energetic costs from behavioral disturbance and/or reduced foraging/energy intake can decrease the fitness of individuals (Lusseau & Bejder 2007) and can result in poor nutrition. Interference with foraging that results in poor nutrition can affect immune function, growth, and development. Interference with behaviors including prey sharing and communication could also change social cohesion and foraging efficiency and therefore the growth, reproduction, and fitness of individuals. Currently, the full extent of impacts of repeated disruptions from a variety of different types of vessels on Southern Residents throughout their range is unknown.

To reduce behavioral and acoustic disturbance and risk of vessel strikes, NMFS implemented regulations in 2011 to prohibit vessels from approaching killer whales within 200 yards (182.9 m), and from parking in the path of the whales within 400 yards (365.8 m) in inland waters of Washington State (76 FR 20870, April, 14, 2011). As part of a 2017 review of the effectiveness of the regulations, NMFS evaluated compliance data from Soundwatch annual reports, WDFW grant reports on monitoring and enforcement activities, and other published data (Ferrara *et al.* 2017). Despite challenges with comparing data before and after 2011, the review found a higher rate of non-compliance with some of the federal regulations after they were codified, including an increase in some risky vessel behaviors that have the highest likelihood of causing a vessel strike. However, there were also indications that compliance may be improving as boaters become more familiar with the requirements. Commercial whale watch vessels were found to have higher compliance than recreational boaters. For example, in 2015, 46% of noncompliance incidents were committed by recreational boaters, while 31% were committed by commercial operators. Compliance was found to improve when WDFW officers were present. The review recommended continued monitoring of vessel activity near the whales, increased enforcement effort, more targeted education and outreach efforts aimed at reaching new boaters in the region, and the adoption of equitable regulations in Canadian waters. These actions, among others, may help maximize the benefits of the regulations for the whales (Ferrara *et al.* 2017).

In addition to vessels, underwater sound can be generated by a variety of other human activities, such as dredging, drilling, construction, seismic testing, and sonar (Richardson et al. 1995; Gordon and Moscrop. 1996; National Research Council 2003). Impacts from these sources can range from serious injury and mortality to changes in behavior. In other cetaceans, hormonal changes indicative of stress have been recorded in response to intense sound exposure (Romano *et al.* 2003). Chronic stress is known to induce harmful physiological conditions including lowered immune function, in terrestrial mammals and likely does so in cetaceans (Gordon and Moscrop. 1996). The intensity and persistence of certain sounds (both natural and anthropogenic) in the vicinity of marine mammals vary by time and location and have the potential to interfere with important biological functions (e.g., hearing, echolocation, communication).

In-water construction activities are permitted by the Army Corps of Engineers (ACOE) under section 404 of the Clean Water Act and section 10 of the Rivers and Harbors Act of 1899 and by the State of Washington under its Hydraulic Project Approval (HPA) program. NMFS conducts consultations on these permits and helps project applicants incorporate conservation measures to minimize or eliminate potential effects of in-water activities, such as pile driving, to marine mammals. Sound, such as sonar generated by military vessels also has the potential to disturb killer whales and mitigation including shut down procedures are used to reduce impacts.

IV. Geographical Area Occupied by the Species

The term "geographical area occupied by the species" is defined as an area that may generally be delineated around a species' occurrences as determined by the Secretary (i.e., range). Such areas may include those areas used throughout all or part of the species' life cycle, even if not used on a regular basis (e.g., migratory corridors, seasonal habitats, and habitats used periodically, but not solely by vagrant individuals) (50 CFR 424.02).

Southern Resident killer whale summer inland habitat use was previously described in the 2006 critical habitat designation (71 FR 69054; November 29, 2006). At that time, few data were available on Southern Resident distribution and habitat use of coastal and offshore areas in the Pacific Ocean. While it was known that the whales occupied these waters for a portion of the year, there were only 28 confirmed and unconfirmed sightings of Southern Residents in outer coastal waters that were available to describe their range when Southern Resident killer whale critical habitat was first designated (Krahn *et al.* 2004, NMFS 2006). In the 2006 designation, these outer coastal areas were included in the identified geographical area occupied by the species, but the lack of data precluded the agency from designating specific areas within the outer coastal range as critical habitat.

Since the 2006 designation, considerable effort has been made to better understand the range and movements of Southern Resident killer whales once they leave inland waters. This critical habitat revision seeks to better define the specific winter outer coastal areas used by the whales within the geographical area occupied by the species. Land- and vessel-based opportunistic and survey-based visual sightings, satellite tracking, and passive acoustic research conducted since 2006 have provided an updated estimate of the whales' coastal range that extends from the Monterey Bay area in California, north to Chatham Strait in southeast Alaska; results from these studies are described in more detail below.

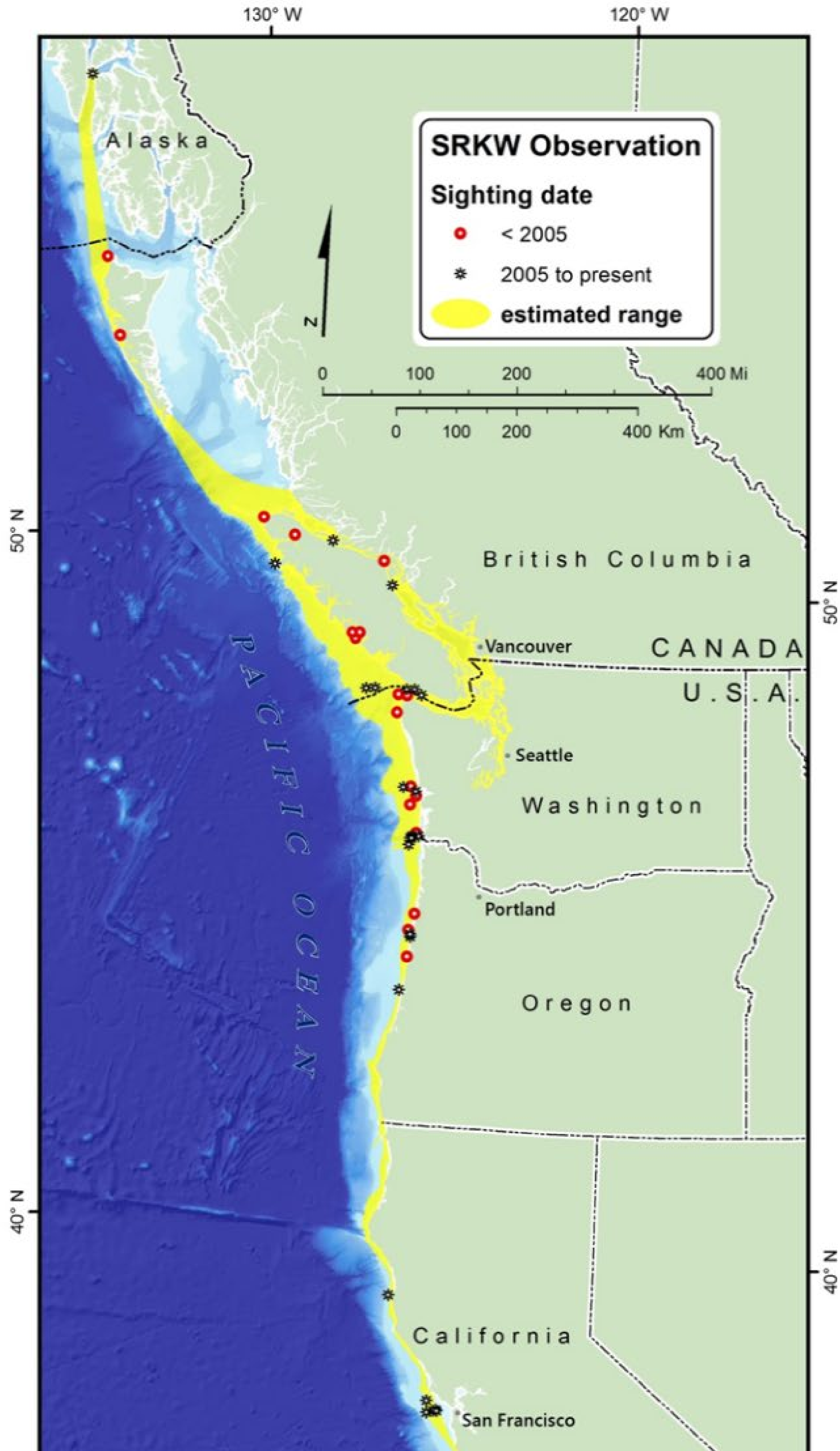
The range of Southern Residents includes coastal and inland waters of British Columbia, Canada, but critical habitat cannot be designated in areas outside of U.S. jurisdiction (50 CFR 424.12(h)). Therefore, although the Southern Residents' range includes outer coastal and inland waters of Canada, we are not considering these areas for designation. Southern Resident killer whale critical habitat has been designated in Canadian waters under the Species at Risk Act (SARA). In a 2008 recovery strategy and a 2011 amended recovery strategy, the Government of Canada identified the Canadian side of Haro and Juan de Fuca Straits, as well as Boundary Pass and adjoining areas in the Strait of Georgia as critical habitat for Southern Residents (Fisheries and Oceans Canada 2011). The Government of Canada recently designated a new critical habitat area for both Northern and Southern Residents in ocean waters on the continental shelf off southwestern Vancouver Island, including Swiftsure and La Pérouse Banks (Fisheries and Oceans Canada 2018). Additional areas are identified as critical habitat for Northern Residents only.

Some Alaskan waters are considered to be within the geographic area occupied by Southern Resident killer whales, but we are not considering expanding critical habitat to Alaskan waters at this time because there is insufficient information about the whales' distribution, behavior, and habitat use in these areas. For example, there is only one sighting of Southern Residents in

Southeast Alaska, in Chatham Strait in 2007. While we can infer that some of the essential habitat features, such as prey, are present to support the whales there, we do not have sufficient data or observations to adequately describe Southern Resident use of habitat features in this area or identify specific areas with those features.

A. Opportunistic Sightings

Confirmed opportunistic sightings of Southern Resident killer whales, obtained from the general public or researchers conducting shipboard surveys (without the use of satellite-linked tags deployed on the whales) have provided important information on the potential range extent for Southern Residents. At the time of the 2006 critical habitat designation, there had only been 28 outer coastal sightings collected since 1975 (including confirmed and unconfirmed sightings off British Columbia, Washington, Oregon, and California through spring 2004) (Krahn *et al.* 2004, Hanson *et al.* 2017). Between 2005 and March 2016, 49 additional opportunistic outer coastal sightings of Southern Residents in the U.S. and Canada (see Figure 6 and Appendix A, Table 5, 6) have helped provide a better understanding of Southern Resident killer whale use of outer coastal habitats, including behaviors that may occur in certain areas. Together, these visual sightings have confirmed Southern Resident killer whales as far north Chatham Strait, southeastern Alaska (Hilborn *et al.* 2012, Hanson *et al.* 2017, Carretta *et al.* 2020) and as far south as the Monterey Bay area, California (Black *et al.* 2001), a north-south range of approximately 2,300 km (1429 mi) (Black *et al.* 2001, Ford *et al.* 2017). The southernmost sighting occurred on January 27, 2008, when Southern Residents were sighted off Cypress Point, Carmel Bay, just south of Monterey Bay, traveling south (N. Black, Monterey Bay Whale Watch, Orca Network sightings archives).



130° W
120° W
SRKW Observation
Sighting date
< 2005
2005 to present
estimated range
N
0 100 200 400 Mi
0 100 200 400 Km
Alaska
British Columbia
Vancouver
CANADA
U.S.A.
Seattle
Washington
Portland
Oregon
PACIFIC OCEAN
California
San Francisco
50° N
40° N

Figure 6. Opportunistic outer coastal sightings data from 1975-2016 (Hanson et al. 2017).

B. Satellite Tracking: Range, Habitat Preferences, and Prey Sampling

Between 2012 and 2016, eight satellite-linked tags were deployed on Southern Residents (2 from J pod, 2 from K pod, and 4 from L pod, all adult males) as a collaborative effort between NWFSC, Cascadia Research Collective, and the University of Alaska with funding support from the U.S. Navy. The goal of this project was to reveal the whales' movements between late December through mid-May and the extent of their geographic range. The tagged whales' winter locations included inland waters of the entire Salish Sea (northern end of the Strait of Georgia and Puget Sound) and outer coastal waters ranging from Vancouver Island, British Columbia south to Pt. Reyes, California.

State-space models developed from this data suggest a total range area encompassing 49,590 sq km (19,147 sq mi) (Hanson *et al.* 2017). While the tagged animals did not travel as far north or south as confirmed opportunistic sightings, the tagging data provide insight into the general home range of each pod and how they overlap, and provide a better understanding as to what areas are used more frequently than others. Consistent with visual sightings, J pod occurred frequently near the western entrance of the Strait of Juan de Fuca but spent relatively little time in other outer coastal areas. In addition, they also had a concentrated occurrence in the northern Strait of Georgia (Hanson *et al.* 2017). K and L pods, however, used the outer coastal waters along Washington and Oregon during winter months with more regularity. They also spent time in coastal waters south into California, though the range based on tag data alone was smaller than when opportunistic sightings data are also included (Figure 7) (Hanson *et al.* 2017).

Satellite tagging also provided details on habitat features and corridors preferred during the outer coastal migrations, including preferred depths and distances from shore. According to Hanson *et al.* (2017), almost all (96.5%) outer coastal locations of satellite-tagged Southern Residents occurred in continental shelf waters of 200 m (656.2 ft) depth or less, 77.7% were in waters less than 100 m (328.1 ft) depth, and only 5.3% were in waters less than 18 m (59 ft). Animals showed a preference for waters between 18 m (59.1 ft) and 54 m (177.2 ft): almost half (49.0%) of the locations were in this depth band, while those depths represent only 18.3% of their outer coastal range (estimated based on a modified minimum convex polygon home range for the tagged whales).

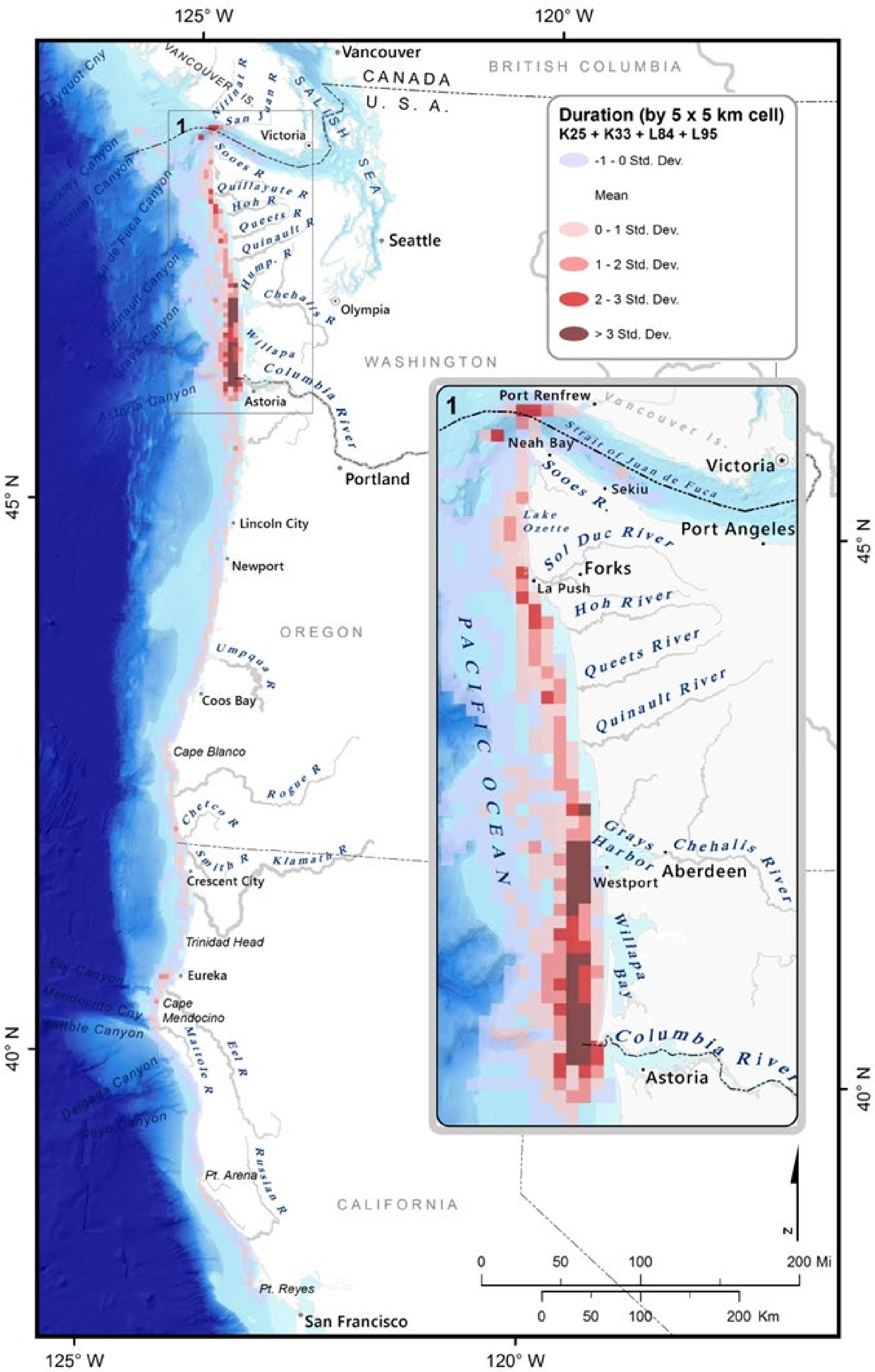


Figure 7. Output of a duration of occurrence model for all unique K and L pod satellite tag deployments (Hanson et al. 2017). The location data were summarized using a vector grid of 5x5 km cells covering the range of the tracking locations. The density for each cell was calculated for total visitation duration in each cell, with a late start (to reduce influence of the tagging location). The model output map indicates variation in usage of areas based on the number of standard deviations (SD) away from the mean. Areas

of highest use had a density more than three SDs above the mean, and the lowest were 0-1 SDs below the mean.

Almost all (95%) of the locations were within 34 km (21.1 mi) of shore; only 5% of locations were in waters within 2 km (1.3 mi) of shore, and only 5% were beyond 34 km (21.1 mi) from shore. Tagged whales moved within a broader north-south corridor off the Washington outer coast (~75% of locations occurred in a 17-km [10.6-mi] wide band that was 3-20 km [1.9-12.4 mi] offshore) compared to when they were off Oregon (10-km wide band [6.2 mi] 2-12 km [1.2-7.5 mi] offshore) or California (6-km [3.7 mi] wide band 2-8 km [1.2-5.0 mi] offshore) (Hanson *et al.* 2017).

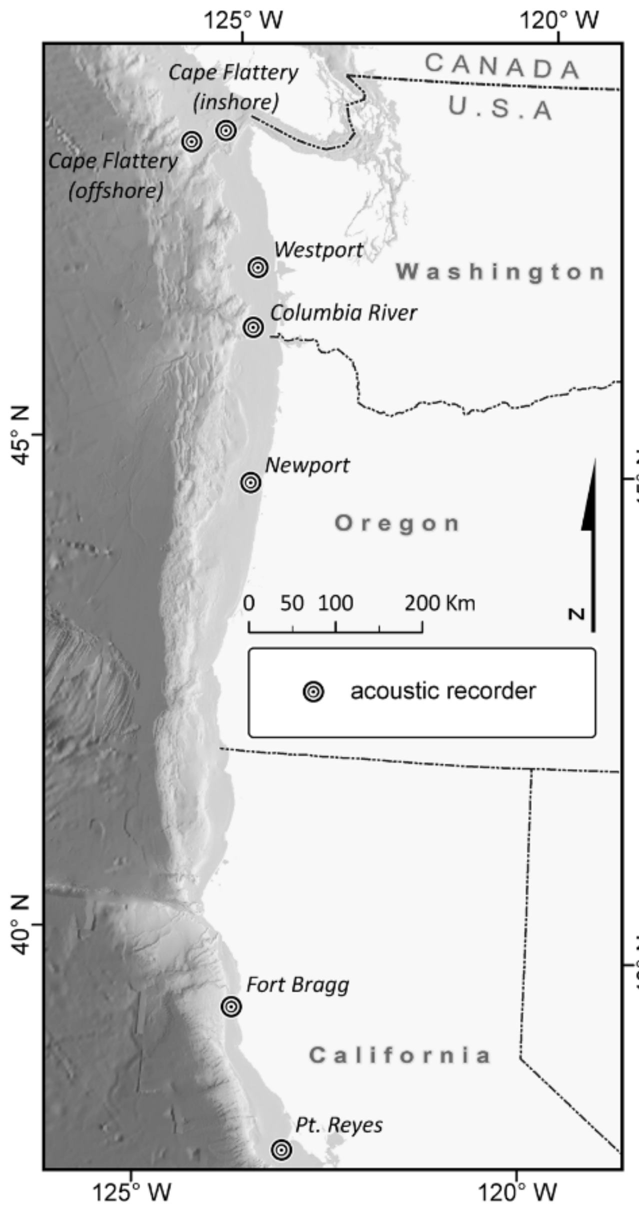
Satellite tagging also identified high-use areas. These areas occurred primarily off the Washington outer coast. Although this area only represented 16.2% of the total satellite tag derived range, the tagged whales spent 53.1% of their time there. Their time was further concentrated between Grays Harbor and the Columbia River (19.1% of their total time) (Figure 7) (Hanson *et al.* 2017). Similar to inland waters, the timing and duration of use in these areas appears to be driven by seasonal abundance of salmonids, particularly Chinook (Ford 2006, Ford *et al.* 2010, Hanson *et al.* 2010, Ford *et al.* 2017, Hanson *et al.* 2021).

The satellite tagging program provided an opportunity for NOAA ship cruises to find the whales in outer coastal waters and collect prey fragments from observed predation events and fecal samples (Hanson *et al.* 2021). Additional data were also collected opportunistically by partners using the satellite tag data to track the whales' movements along the coast (Hanson *et al.* 2021). This data provides specific information on the location of predation events and detailed information on the specific species and runs of salmon the whales were eating in their outer coastal habitat (Figure 5).

C. Acoustic Detections

Over the past decade, efforts have been made to collect and analyze acoustic data to better understand occurrence patterns of Southern Residents in outer coastal habitats. Starting in 2006, passive acoustic recorders were deployed throughout the known Southern Resident range off the coasts of Washington, Oregon, and California (Figure 8). These studies, in conjunction with data collected from satellite tags and opportunistic sightings, contributed to the state-space modelling predictions of high-use areas previously mentioned. From 2006-2011, 7 acoustic recorders were deployed, with additional deployments beginning in 2014, including 17 sites off the Washington coast in the fall of 2014 (Figure 8).

Acoustic data indicate that K and L pods spend a relatively large amount of time off the outer coast of Washington, with detections in every month of the year, though they were also detected off the coast of Oregon in January-March, May, and December, and off the coast of California in January, February, May, and December (Hanson *et al.* 2013; NWFSC unpubl. data). In outer coastal waters, J pod was only detected on the northern-most recorders (Hanson *et al.* 2013, and also see Emmons *et al.* 2021) and only infrequently, whereas K and L pods were detected on all recorders, particularly those in the nearshore waters between Westport and the Columbia River.


125° W
120° W
CANADA
U.S.A
Cape Flattery (inshore)
Cape Flattery (offshore)
Westport
Washington
Columbia River
45° N
Newport
Oregon
0 50 100 200 Km
N
acoustic recorder
40° N
Fort Bragg
California
Pt. Reyes

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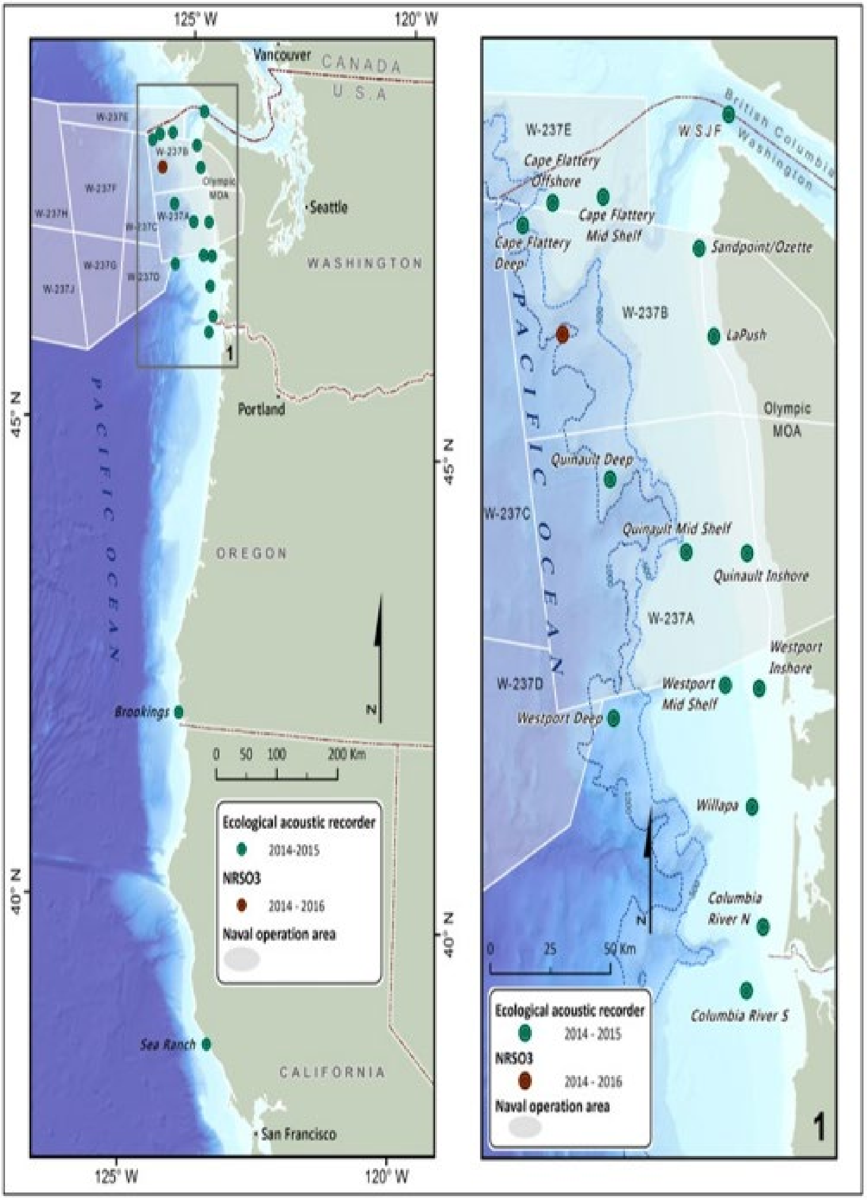

Figure 8. Locations of passive acoustic recorders deployed (left) from 2006-2011 (Hanson et al. 2013) and (middle and right) beginning in the fall of 2014 (Hanson et al. 2017).

A key finding was that Southern Residents occur near the mouth of the Columbia River in the late winter/early spring more often than expected, coinciding with the presence of spring run Columbia River Chinook salmon (Hanson *et al.* 2013). This supports previous findings of the importance of Columbia River Chinook salmon to the diet of at least some portion of this Southern Resident population (Zamon *et al.* 2007, Hanson *et al.* 2010, Hanson *et al.* 2013).

Passive acoustics alone, however, may underestimate whale presence and duration of use since they cannot account or correct for animals that are present but not vocalizing. Additionally, the placement of recorders is often limited to Southern Residents' known range, so they may not account for unidentified habitats the whales may use. The placement of the recorders is also sometimes limited by human use and are placed in areas to avoid conflicts (e.g., fisheries, shipping traffic), which may not be ideal habitat for the species. Recorders may also miss animal vocalizations due to anthropogenic or natural disturbances (e.g., vessel traffic, storms). Therefore information collected by passive acoustics is most informative if used in combination with other sources, such as opportunistic sightings and satellite tag data.

D. Combined Datasets

Looking at the datasets in combination is important for understanding the movements, range, and habitat use by Southern Residents. In isolation, each dataset is limited, either spatially or temporally. Passive acoustics studies have greatly increased our knowledge of the seasonal and annual occurrence of Southern Residents in the outer coastal waters, however this data may underestimate habitat use or duration of occurrence in particular areas (Hanson *et al.* 2013). Satellite tagging is temporally limited, however, it is spatially unbiased. Used in combination and with incorporation of visual sightings, movements between areas and duration of area use can be better assessed, broadening our understanding of how Southern Residents move between and use outer coastal habitats (Hanson *et al.* 2013).

V. Physical or Biological Features Essential to Conservation

A. ESA Regulations

Section 3(5)(A) of the ESA describes the defining factors for identifying both occupied and unoccupied critical habitat. Areas meeting the statutory definition within the occupied range of the listed species must contain physical or biological features essential to the conservation of the species that may require special management consideration or protection. The ESA does not specifically define physical or biological features; however, joint NMFS and U.S. Fish and Wildlife (USFWS) regulations at 50 CFR 424.02 provide guidance on how physical or biological features are expressed (81 FR 7413; February 11, 2016).

Physical and biological features support the life-history needs of the species, including but not limited to, water characteristics, soil type, geological features, sites, prey, vegetation, symbiotic species, or other features. A feature may be a single habitat characteristic, or a more complex combination of habitat characteristics. Features may include habitat characteristics that support ephemeral or dynamic habitat conditions. Features may also be expressed in terms relating to principles of conservation biology, such as patch size, distribution distances, and connectivity.

B. Identification of Essential Features

Killer whale habitat utilization is dynamic, and specific breeding, calving or resting areas are not currently documented. Births occur largely from October to March, but may take place in any month (Olesiuk *et al.* 1990) and therefore potentially in any part of the whale's range. Southern Residents are highly mobile and can travel up to 239 km (148.5 mi) in a 24-hour time period (NWFSC unpubl. data), allowing rapid movements between areas. The three primary concerns raised as potential factors in the decline of Southern Residents are: prey availability, contaminants/pollution, and vessel effects (NMFS 2008a). There are habitat components for each of these concerns that relate to the essential features necessary for killer whale conservation.

In consideration of the natural history of Southern Resident killer whales and their habitat needs, the following features were identified in the Southern Resident killer whale 2006 critical habitat designation as essential to the conservation of the species within the inland summer habitat. These features included:

- Water quality to support growth and development;
- Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and
- Passage conditions to allow for migration, resting, and foraging.

In the revision, these essential habitat features are maintained and applied to the newly identified specific areas described in section VI ('Specific Areas'). The following sections describe the essential physical or biological features as they apply to the newly designated critical habitat areas.

B.1. Water quality to support growth and development

Water quality supports Southern Resident killer whales' ability to forage, grow, and reproduce free from disease and impairment. Southern Resident killer whales are highly susceptible to biomagnification of pollutants, such that chemical pollution is considered one of the prime impediments to their recovery (NMFS 2008a). Water quality is essential to the whales' conservation, given the whales' present contamination levels, small population numbers, increased extinction risk caused by any additional mortalities, and geographic range (and range of their primary prey) that includes highly populated and industrialized areas. Water quality is especially important in high-use areas where foraging behaviors occur and contaminants can enter the food chain. The absence of contaminants or other agents of a type and/or amount that would inhibit reproduction, impair immune function, result in mortalities, or otherwise impede the growth and recovery of the Southern Resident population is a habitat feature essential for the species' recovery. Exposure to oil spills also poses additional direct threats as well as longer-term population level impacts; therefore, the absence of these chemicals is of the utmost importance to Southern Resident conservation and survival.

B.2. Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth

Southern Resident killer whales are top predators that show a strong preference for salmonids in inland waters, particularly larger, older age class Chinook (age class of 3 years or older) (Ford & Ellis 2006, Hanson *et al.* 2010). Samples collected during observed feeding activities, as well as the timing and locations of killer whales' high-use areas that coincide with Chinook salmon runs, suggest the whales' preference for Chinook extends to outer coastal habitat use as well (Hanson *et al.* 2017, Shelton *et al.* 2018, Hanson *et al.* 2021). The diet of the whales in outer coastal areas is more varied than those of inland habitats, which suggests there may not be sufficient density of Chinook along the coast to sustain them. Habitat conditions should support the successful growth, recruitment, and sustainability of abundant prey to support the individual growth, reproduction, and development of Southern Residents.

Southern Residents need to maintain their energy balance all year long to support daily activities (foraging, traveling, resting, socializing) as well as gestation, lactation, and growth. Maintaining their energy balance and body condition is also important because when stored fat is metabolized, lipophilic contaminants may become more mobilized in the bloodstream, with potentially harmful health effects (Mongillo *et al.* 2016). As previously discussed, in order to meet Southern Resident killer whale energetic demands, consumed prey must meet daily minimum dietary caloric needs ranging from 41,376 kcal to 224,521 kcal per day, depending on the whale's age class and life history (Noren 2011).

Several studies in the past have found correlations between Chinook salmon abundance indices and Southern Resident killer whale demographic rates (Ford et al. 2005; Ford et al. 2010; Ward et al. 2009; Ward et al. 2013). Resident killer whale survival rates (Ford *et al.* 2005, Ford *et al.* 2010) and fecundity (Ward *et al.* 2009) have been correlated with Chinook salmon abundance, such that probability of calving increased by 50% between low and high Chinook abundance years (Ward *et al.* 2009). Ward *et al.* (2016) also found correlations between the demographic rates of two geographically isolated populations of resident killer whales (Southern Resident killer whales and Southeast Alaska killer whales), suggesting that the shared prey (particularly southern stocks of Chinook salmon) may be the environmental driver for this correlation. Both killer whale populations had similar trends in fecundity and survival, although the Alaska population is larger and has an upward population trend. The reasons for the differences are unknown but may indicate Southeast Alaska residents may have a more varied diet and therefore more easily adapt during years of lower Chinook abundance (Ward *et al.* 2016), or that they have access to more, or higher quality Chinook prior to the salmon migration into Southern Resident killer whales foraging habitat.

In recent years, the relationship between Chinook salmon abundance and Southern Resident demographic rates has weakened, as Southern Resident status has declined despite varying levels of Chinook abundance (NMFS 2020a, 2021b; Pacific Fishery Management Council 2020a). There are several challenges to quantitatively characterize the relationship between Southern Resident killer whales and Chinook salmon, including (1) there are multiple, interacting factors at play; (2) the strength of any one effect likely varies through time leading to a situation known as "non-stationarity"; and (3) the small population size of the Southern Resident population makes detection of any true effects difficult, using statistical analyses, due to a high degree of random variation (NMFS 2020a). Multiple threats affect Southern Resident killer whale's demographic performance through time, in addition to random chance, and these effects can confound the analysis of the effects of prey abundance (NMFS 2020a). Although there is currently no quantitative model that identifies a low abundance that will definitively cause adverse effects to the whales or appreciably alter the value of their habitat, there is evidence Southern Resident and other killer whale populations that are known to consume Chinook salmon may have experienced adverse effects from low prey availability in the late 1990s (NMFS 2020a).

A recent risk assessment analysis related past Southern Resident killer whale demographic performance with estimates of Chinook salmon abundances in specific time (October–April, May–June, and July–September) and areas (off the coasts of Washington, Oregon, California and in the Salish Sea and off Southwest Coast Vancouver Island) (Pacific Fishery Management Council 2020a). However, similar to past efforts, they also found statistically predicting the relationship between Southern Resident killer whales and Chinook salmon to be challenging. They found one of the fitted regressions met the criterion of statistical significance ($p \leq 0.05$) for the relationship between winter Chinook abundance North of Cape Falcon, OR (NOF) and Southern Resident survival with one year time lag. Other relationships were significant at the $p<0.1$ level and these occurred for biologically significant times and places for Southern Residents. The Workgroup noted though that regression results should be interpreted with caution, for reasons listed above (multiple interacting factors, non-stationarity, and high degree of random variation).

Intuitively, at some low Chinook salmon abundance level, the prey available to the whales will not be sufficient to forage successfully, leading to adverse effects (such as reduced body condition and growth and/or poor reproductive success). When prey is scarce, whales likely spend more time foraging than when it is plentiful. Increased energy expenditure and reduced prey consumption could result in nutritional stress, which may affect the whales' survival and fecundity (NMFS 2020a).

Chinook are the predominant species in the diet of Southern Residents year-round, with K and L pods being particularly tied to Chinook stocks along the outer coast that are currently listed under the ESA (Central Valley, Columbia River, and Puget Sound). Many wild salmon stocks are at fractions of their historic levels. Beginning in the early 1990s, 28 evolutionarily significant units (ESUs) and DPSs of salmon and steelhead in Washington, Oregon, Idaho, and California were listed as threatened or endangered under the ESA. Historically, overfishing, habitat losses, and hatchery practices were major causes of decline. Basin- and local-scale physical and biological conditions affect salmon growth and survival in the ocean through "bottom-up" and "top-down" ecological changes in the food chain (Peterson *et al.* 2018). Periods of poor ocean conditions (warm and unproductive waters) have reduced populations already weakened by the degradation and loss of freshwater and estuary habitat, fishing, hydropower system management, and hatchery practices.

In addition to sufficient quantity of prey, those fish need to be accessible and available to the whales. Depending on pod migratory behavior, availability of Chinook along the outer coast is likely limited at particular times of year (e.g. winter months) due to run timing of various Chinook stocks. Prey availability may also be low when the distribution of preferred adult Chinook is relatively less dense (spread out) prior to their aggregation when returning to their natal rivers. Prey availability may also be affected by competition from other predators including other resident killer whales, pinnipeds, and fisheries (Chasco *et al.* 2017).

Availability of prey to the whales may also be impacted by anthropogenic sound if it raises average background noise to a level that is expected to chronically or regularly reduce echolocation space (Veirs *et al.* 2016, Joy *et al.* 2019), and therefore could limit a whale's ability to find/access the prey critical habitat feature. For example, ship noise was identified as a concern because of its potential to interfere with Southern Resident killer whale communication, foraging, and navigation (Veirs et al. 2016). Research has shown that Southern Residents spend more time traveling and performing surface active behaviors and less time foraging in the presence of all vessel types, including kayaks, and that noise from motoring vessels up to 400 meters away has the potential to affect the echolocation abilities of foraging whales (Holt 2008; Lusseau *et al.* 2009; Noren *et al.* 2009; Williams *et al*. 2010). Commercial sonar systems designed for fish finding, depth sounding, and sub-bottom profiling are widely used on recreational and commercial vessels and are often characterized by high operating frequencies, low power, narrow beam patterns, and short pulse length (National Research Council 2003). Frequencies fall between 1 and 500 kilohertz (kHz), which is within the hearing range of some marine mammals including killer whales and may have masking effects (i.e., sound that precludes the ability to detect and transmit biological signals used for communication and foraging). In-water anthropogenic sound is generated by other sources beside vessels, including construction activities, and military operations, and may affect availability of prey to Southern Residents by interfering with hearing, echolocation, or communication depending on the intensity, persistence, timing, and location of certain sounds in the vicinity of the whales (*see* NMFS 2008a). Therefore, anthropogenic noise may affect the availability of prey to Southern Residents by reducing echolocation space used for foraging and communication between whales (including communication for prey sharing).

Age, size, and caloric content all affect the quality of prey. The age of the Chinook salmon Southern Residents consumed were relatively younger than those consumed by Northern Resident killer whales and thus smaller, with less caloric value (Hanson *et al.* 2021). The more diverse diet along the outer coast includes salmonids with lower caloric content than Chinook (O'Neill *et al.* 2014), as well as other non-salmonids, most of which also have a lower energy density (Perez 1994, Anthony *et al.* 2000, Davis 2003).

Also, size and age structure in Chinook salmon has substantially changed across the Northeast Pacific Ocean. Since the late 1970s, adult Chinook salmon (ocean ages 4 and 5) along most of the eastern North Pacific Ocean are becoming smaller, whereas the size of age 2 fish are generally increasing (Ohlberger et al. 2018). Additionally, most of the Chinook salmon populations from Oregon to Alaska have shown declines in the proportions of age 4 and 5 year olds and an increase in the proportion of 2 year olds; the mean age of Chinook salmon in the majority of the populations has declined over time. For Puget Sound Chinook salmon (primarily hatchery origin), there were little or weak trends in size-at-age of 4 year olds and the declining trend in the proportion of older ages in Washington stocks was also observed but slightly weaker than that in Alaska populations (Ohlberger et al. 2018). Reasons for this shift may be largely due to direct effects from size-selective removal by marine mammals and fisheries, followed by evolutionary changes toward these smaller sizes and early maturation (Ohlberger et al. 2019). No matter the cause, these changes would result in lower caloric value of individual salmon.

Contaminants and pollution also affect the quality of Southern Resident killer whale prey. Contaminants enter marine waters and sediment from numerous sources, but are typically concentrated near areas of high human population and industrialization. Once in the environment these substances proceed up the food chain, accumulating in long-lived top predators like Southern Resident killer whales. High levels of these contaminants can impact development of key physiological functions in growing calves, immune function, and reproduction affecting individuals' survival and overall population growth. Chemical contamination of prey is a potential threat to Southern Resident killer whale critical habitat, despite the enactment of modern pollution controls in recent decades, which were successful in reducing, but not eliminating, the presence of many contaminants in the environment.

B.3. Passage conditions to allow for migration, resting, and foraging

Southern Resident killer whales are highly mobile, can cover large distances, and range over a variety of habitats, including inland waters and open ocean coastal areas from the Monterey Bay area in California north to Southeast Alaska. The whales' habitat utilization is dynamic and specific breeding, calving, or resting areas are not currently documented. Southern Residents require open waterways that are free from obstruction (e.g., physical, acoustic) to move within and migrate between important habitat areas throughout their range, communicate, find prey, and fulfill other life history requirements. As an example of an "acoustic obstruction," killer whale occurrence in the Broughton Archipelago, Canada declined significantly when acoustic harassment devices were in use at a salmon farm, and returned to baseline levels once the devices were no longer used (Morton & Symonds 2002), indicating the introduction of this chronic noise source into the environment acted as an acoustic barrier and/or deterrent to the whales' use of the area. Behavioral responses of killer whales to received noise levels from ships were estimated using a dose-response function (Williams et al. 2014). The authors predicted that the whales would have a 50% chance of responding behaviorally to ship noise when received noise levels were approximately 130 dB rms. Following this study, Holt et al. (2017) utilized Digital Acoustic Recording Tags (DTAGs) to measure received noise levels by the whales (in decibels (dB) re 1 Micropascal (μPa)) in inland waters. The received noise levels (in the 1 to 40 kHz band) measured in inland waters were between 96 and 127 dB re 1μPa, with an average of 108 dB ± 5.5. It is currently unclear what levels of vessel noise would be loud enough to have more than a short-term behavioral response. But we would assess activities to consider if any acoustic obstructions create a barrier that restricts movements through or within an area necessary for migration, resting, foraging, or social behavior

The passage feature may be less likely to be impacted in coastal ocean waters compared to the more geographically constricted inland waters because the whales may be able to more easily navigate around potential obstructions in the open ocean, but these passage conditions are still a feature essential to the whales' conservation and may require special management or protection. Noren and Hauser (2016) used surface-based observations to assess Southern Resident killer whales' behavior and fine-scale habitat use within the inland critical habitat Summer Core Area in Haro Strait and waters around the San Juan Islands. They found that the whales engaged in most activity states (travel, forage, rest, and social behavior) throughout the area, but that foraging and resting predominantly occurred in some localized regions. Similar data collection and analysis has not been conducted to identify geographic variability or hotspots in the whales' activity or behavioral states in waters along the outer coast. However, analysis of Southern Resident killer whales' movement patterns on the outer coast from satellite tag data has revealed preferred depth bands and distances from shore that suggest potential travel corridors, and variations in travel speed or duration of occurrence that may indicate different behavioral states (Hanson *et al.* 2017). For example, in areas where the whales are primarily foraging or resting, the duration of occurrence would be expected to be longer and travel speeds slower, while the opposite would be true for areas where the whales are primarily transiting. Satellite tag data revealed the whales' outer coastal locations were almost entirely (96.5%) in continental shelf waters of 200 m (656.2 ft) or less depth, with a preference (49% of locations) for waters between 18 m-54 m, a depth band that represents 18.3% of the whales' total outer coastal range (Hanson *et al.* 2017). Tagged whales used a broader range of depths off the North coast of Washington compared to other areas of their outer coastal range. Overall, the tagged whales' locations were typically (95%) within 34 km (21.1 mi) of shore (with 83% within 20 km [12.4 mi] of shore and 54% within 10 km [6.2 mi] of shore), and were rarely located in shallow waters within 2 km (1.2 mi) of shore (5%) or in deeper waters outside of 34 km (5%) (Hanson *et al.* 2017).

B.4. Consideration of sound as an essential feature

As discussed in the Hearing and Vocalizations section above (section III.D), Southern Resident killer whales produce and detect sounds for communication, navigation, and foraging. An acoustic environment, or soundscape, in which the whales can detect and interpret sounds is critical for carrying out these basic life functions. In recognition of this, we previously considered identifying "sound levels that do not exceed thresholds that inhibit communication or foraging activities or result in temporary or permanent hearing loss" as a potential essential feature of the whales' habitat (69 FR 76673; December 22, 2004), but ultimately concluded that we lacked sufficient information to do so. As described in the Background section above (section I), CBD petitioned us to again consider identifying in-water sound as an essential feature of the currently designated critical habitat and any new designation. Specifically, CBD requested that we identify in-water sound levels that: "(1) do not exceed thresholds that inhibit communication or foraging activities, (2) do not result in temporary or permanent hearing loss to whales, and (3) do not result in abandonment of critical habitat areas" (CBD 2014).

We considered the request, and also examined new information that has become available since publication of the 2006 critical habitat designation final rule, but similar to limitations in our knowledge in 2006, at this time we are not able to identify specific in-water sound levels or thresholds for communication, behavioral or displacement impacts as requested in the petition. We acknowledge that adverse habitat-related effects may stem from the introduction of a chronic noise source that degrades the value of habitat by interfering with the sound-reliant animal's ability to gain benefits from that habitat (*i.e.*, altering the conservation value of the habitat). However, NMFS does not currently have a quantifiable methodology to establish thresholds for determining when chronic noise reaches a level such that it alters the conservation value in this way. As such, we are unable to identify sound as an essential feature that would identify in-water thresholds relevant to communication, foraging, or use of areas.[2] Instead, we are able to meaningfully evaluate the effects of anthropogenic noise on Southern Residents and their habitat qualitatively and can effectively do so through the prey and passage essential features, as well as analyses of effects to individual whales themselves, both of which we discuss in detail below.

Although we are unable to identify specific sound level thresholds, we are able to meaningfully evaluate the impact of sound on Southern Resident killer whale critical habitat through our analysis of other essential features. In our experience evaluating effects on Southern resident killer whale critical habitat in inland waters, we are already able to assess adverse habitat-related effects of anthropogenic sound by evaluating impacts to the prey and passage essential features of existing critical habitat for Southern Residents. We will use the same approach for evaluating these effects in newly designated critical habitat, consistent with our existing practice in inland waters critical habitat. For example, we evaluate whether chronic anthropogenic sound might alter the conservation value of habitat by reducing the availability of the whales' prey in a particular foraging area by reducing the effective echolocation space for the whales to forage (see V.B.2 Prey feature), or creating a barrier that restricts movements through or within an area necessary for migration, resting, foraging, or social behavior (see V.B.3 Passage feature). If data indicate that anthropogenic noise from a particular federal action is preventing or impeding access to prey (by acoustic barrier or reducing prey availability) or preventing or impeding successful feeding within designated critical habitat, then such effects would likely constitute an adverse effect on the prey essential feature and thus the designated area of critical habitat itself and for that reason should likely also be addressed under section 7 of the ESA (pursuant to the standard for considering whether an action poses destruction or adverse modification to critical habitat). Thus, the essential features as defined here will provide a measure of protection from noise degradation to the extent that an action might cause such noise that would interfere with the whales' ability to use (e.g., move through as in passage or access prey) and successfully feed within the critical habitat (prey feature, including social communication for prey sharing). Therefore, similar to existing critical habitat, we do not consider it necessary to identify sound as a separate essential feature.

Notably, under the ESA, we also separately consider impacts of anthropogenic sound outside of critical habitat protections, via direct and indirect effects on individual whales themselves. For example, indirect effects of noise on Southern Residents may include consideration of noise interference with whale communication and social behavior. Effects of anthropogenic noise that result in "take" or harm to individual whales are currently addressed under section 7 of the ESA (pursuant to the standard for considering whether a proposed action would jeopardize the continued existence of the species). NMFS has an established framework and thresholds for considering impacts to marine mammals' hearing (specifically temporary or permanent hearing loss), as outlined in our "*Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing"* (NMFS 2018a), and NMFS is also working to refine its guidance on the effects of anthropogenic sound on marine mammal behavior. We will continue to evaluate and manage direct and indirect effects of anthropogenic sound on individual animals and the

[2] CBD's petition also requested an identification of in-water sound levels that "do not result in temporary or permanent hearing loss to whales." Such impacts are not impacts to habitat but to the whales themselves and would be considered under Section 7 of the ESA, as discussed below.

population relative to the jeopardy standard in ESA section 7 analyses and through MMPA incidental take authorizations.

As discussed above, NMFS does not currently have a quantifiable methodology to establish thresholds for when chronic noise reaches a level that degrades the value of habitat. Instead, as we have done here for Southern Resident killer whales, we have considered the effects of chronic noise qualitatively for other species, albeit in different ways. For example, NMFS identified sound-related essential features (or characteristic of an essential feature) in a non-quantitative manner in the critical habitat designations for the Cook Inlet beluga whale DPS and Main Hawaiian Islands (MHI) insular false killer whale DPS. The MHI IFKW designation considered the effects of sound on navigation, communication, and foraging by including sound as a characteristic of the habitat feature (74 FR 63095; December 2, 2009). Similarly, we are able to analyze the equivalent effects for Southern Resident killer whales through the passage and prey features as these similarly address navigation for access to areas, communication for prey sharing, and movement for foraging (access to prey). For Cook Inlet beluga whale critical habitat, the sound feature focuses on identifying noise levels that do not lead to abandonment of the area (83 FR 35062; July 25, 2018) providing a level of protection that is equivalent to our consideration of acoustic barriers in the passage feature for Southern Resident killer whales (passage feature addresses access to areas). Therefore, descriptions of both sound essential features for false killer whales and beluga whales inform the qualitative assessment of habitat-related impacts from anthropogenic sound, specifically on passage, access to critical habitat, and use of critical habitat, similar to passage and prey features for Southern Residents killer whales that equally address access and use of critical habitat. Although a sound-related feature was explicitly identified for false killer whales and beluga whales, the resulting effect is not different from our consideration of sound within the prey and passage features for Southern Resident killer whales; identifying sound as a stand-alone feature here would be duplicative and would not result in any meaningful additional protections or considerations.

Finally, no qualitative sound-related feature has been identified for other species that have more extensive ranges similar to Southern Resident killer whales such as humpback whales (proposed critical habitat 84 FR 54354; December 9, 2019), North Atlantic right whales (81 FR 4838; January 27, 2016), and north Pacific right whales (68 FR 19000; April 8, 2008), or other marine mammal critical habitat.

While identifying sound as a separate habitat feature or a component “characteristic” of a feature highlights to federal agencies the significance of sound levels in support the whales’ habitat use and its conservation value, we have outlined in this report how potential habitat-related effects of anthropogenic noise (e.g., abandoning critical habitat areas, creating a barrier that restricts movement through or within a critical habitat area, impairing feeding, communication, and other social behavior) on the conservation value of habitat can be addressed through the prey and passage essential features identified for Southern Resident killer whales. It is for this reason that activities producing sound impacting Southern Resident prey availability or safe and unrestricted passage are considered activities that may require special management considerations, as detailed in section VII.

VI. Specific Areas

Specific areas within the geographic range occupied by the species that were identified in the 2006 critical habitat designation are carried forward unchanged by this critical habitat revision. As discussed in section IV, at the time of the 2006 designation, few data (28 confirmed and unconfirmed sightings) were available on Southern Resident distribution and habitat use of outer coastal and offshore areas in the Pacific Ocean. In the 2006 designation, these outer coastal areas were included in the identified geographical area occupied by the species, but the lack of data precluded the agency from determining whether any specific areas within the coastal range met the definition of critical habitat. Since then, NMFS and our partners have conducted research and collected data that allow us to better characterize the whales' habitat use. These data are now sufficient to identify specific areas within the whales' coastal range.

The CBD requested that we identify critical habitat in areas of the Pacific Ocean between Cape Flattery, Washington, and Point Reyes, California, extending approximately 47 miles (76 km) offshore. This requested area was based mainly on the extent of the whales' movements from NMFS' satellite tag data: tagged animals traveled as far south as Point Reyes and as far offshore as 47 miles. However, the petition stated that because NMFS was continuing to analyze data describing the Southern Residents' use of coastal and offshore waters, the petition requested we "refine this proposal, as necessary, to include additional inhabited zones or to focus specifically on areas of concentrated use" (CBD 2014). To delineate specific areas, we relied on the satellite tag data but also incorporated information on sightings, acoustic data, and prey sampling. As a result, the specific areas identified in the final rule differ in their boundaries from the petitioner's request.

We identified six specific areas off the U.S. West Coast, delineated based on their habitat features and use by Southern Resident killer whales (Figure 9, Table 1). These areas are described in more detail in the following sections. The six areas encompass most of the whales' U.S. coastal range, and they vary in size. The ESA and regulations provide the agency discretion to determine the scale at which specific areas are identified (50 CFR 424.12; 81 FR 7413, February 11, 2016). As discussed below, we selected the boundaries between areas to reflect the spatial scale of the whales' movements and behavioral changes (e.g., where tagged whales were primarily traveling versus observed foraging, therefore differences in use of habitat features between areas), as well as to align with some existing fishery management boundaries (e.g., geographic points used by the Pacific Fishery Management Council in salmon management, see Figure 25 in Appendix B; Pacific Fishery Management Council 2016). These boundary delineations can aid in future consultation analyses by providing information on which habitat features may be most impacted by federal actions in different areas. The specific areas also assist in evaluating potential impacts of designation as further discussed in the Final Economic Report (Industrial Economics [IEc] 2021) and Final ESA Section 4(b)(2) Report (NMFS 2021a). The six areas have some similarities and contain all three essential features, but the primary feature varies between areas. Table 1 identifies a primary feature for each specific area.

Beginning at the westernmost extent of the currently designated Strait of Juan de Fuca critical habitat area, the specific areas span the U.S. West Coast from the U.S. international border with Canada south to Point Sur, California, which is just south of the southernmost sightings of

Southern Resident killer whales in the Monterey Bay area. On January 27, 2008, Southern Residents were sighted off Cypress Point, Carmel Bay, just south of Monterey Bay, traveling south (N. Black, Monterey Bay Whale Watch, Orca Network sightings archives). Given uncertainty in the exact extent of the whales' southward movements, we elected to delineate the southern boundary of the specific area just south of the last sighting (by approximately 20 mi (32.2 km)) and align the boundary with the existing salmon management area boundary at Point Sur, California (see below) (Pacific Fishery Management Council 2016).

The inshore (eastern) boundary of the areas is delineated by a continuous line along the coast at 6.1-m (20-ft) depth relative to mean high water (i.e., nearshore areas between the line of mean high tide[3] and a depth of 20 feet relative to this line). This continuous line crosses river mouths and entrances to semi-enclosed bays and estuaries at the 20 ft depth contour where available or crossing at significant barriers (e.g. jetties). This is consistent with the approach used for the 2006 critical habitat designation in inland waters. We do not have data indicating that the whales frequently occur in waters shallower than 20 ft. For example, based on data from four satellite-tagged Southern Resident killer whales, less than 1% of the whales' outer coastal locations were in depths less than 6 m (NWFSC unpubl. data). In addition, there are no data from sightings or satellite tags to indicate that Southern Residents enter river mouths or semi-enclosed bays and estuaries along the outer coast, although data indicate the whales do use the open embayment of Monterey Bay in California. Based on this information, we defined the shoreward boundary of the specific areas as a contiguous line along the outer coast at 20 ft in depth, relative to the mean high water line.

We note that not designating waters shallower than 20 ft as critical habitat does not preclude consultation on activities that occur in these shallow nearshore areas or in upstream areas. The ESA section 7 requirement that federal agencies ensure their actions are not likely to adversely modify critical habitat applies not only to actions occurring within designated critical habitat, but also to actions occurring outside of designated areas which can impact the features of the critical habitat. For example, consultation could be required on activities that occur in waters shallower than 20 ft or in upstream freshwater locations if those actions are likely to adversely affect essential habitat features, such as water quality or prey quantity, quality, or availability, in designated critical habitat. In addition, management and protections remain in place for areas that are important to Southern Resident killer whale prey, such as rivers and adjacent riparian zones designated as critical habitat for ESA-listed Chinook and other salmon.

The offshore (western) boundary of the areas is the 200-m (656.2-ft) isobath.[4] We selected this boundary because movement data from satellite-tagged Southern Resident killer whales indicate that most outer coastal locations were in water depths of 200 m or less (96.5%) and within 34 km (21.1 mi) from shore (95%) (Hanson *et al.* 2017). The limited information available on the

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[3] The inshore boundary of critical habitat in inland waters is 20 feet of water depth relative to the extreme high water line. However, due to differences in the vertical datum (surface of zero elevation to which heights are referenced) of the available coastal shoreline data, the inshore boundary for coastal critical habitat is 20 feet of water depth relative to the mean higher water (MHW) line.

[4] As described in the area-specific sections below, Areas 1 and 2 share the same latitudinal (northern and southern) boundaries but are separated longitudinally at the 50-m (164.0-ft) isobath, such that Area 1 ranges from 6.1-50 m depth while Area 2 ranges from 50-200 m depth.

distribution of salmon in offshore waters indicates Southern Resident killer whale prey (an essential feature of the habitat) is present in waters of 200 m or less. Catch data and interviews with commercial fishermen indicate that maturing Chinook salmon are found in highest concentrations along the continental shelf within 60 km (37.3 mi) of the Washington, Oregon, and California coastlines (Pacific Fishery Management Council 2014a). Fishery records are generally only collected during May through September. Additional fishery information is available from the groundfish fishery. The trawl fishery for whiting encounters a variety of Chinook runs as bycatch; the highest bycatch per unit of effort occurs in waters 100 m (328.1 ft) or less in depth, and overall bycatch rates are inversely correlated with depth (i.e., higher bycatch rates per unit of effort in shallower water than deeper water).

As a first step in identifying specific areas, we selected the latitudinal boundaries between the specific areas to coincide with some of the coastal salmon management area boundaries as defined in the Pacific Salmon Fishery Management Plan (FMP) and used for the management of salmon harvest (Chinook and Coho specifically) (see Figure 25 in Appendix B). Although the areas of highest Southern Resident killer whale occurrence, as indicated by a duration-of-occurrence model from satellite tag data (Hanson *et al.* 2017), did not precisely match the salmon management areas, they generally align with the available information on salmonid and other fish species that may be prey to Southern Residents. For example, the whales' highest use areas occurred in the North of Falcon fishery management area between Cape Falcon, Oregon and the Canadian border, and relatively high use occurred within the Klamath Management Zone. Similar to inland waters, we assume that Southern Resident killer whales respond to regional and seasonal abundance of salmon, particularly Chinook runs. We then adjusted some of the boundaries to better reflect what we know about the whales' use of the areas (e.g., areas where foraging has been observed and/or prey samples collected, versus areas whales are considered mainly to be traveling through). We selected Cape Meares, Oregon as the southern boundary of Areas 1 and 2 instead of Cape Falcon just to the north, because the Cape Meares boundary encompassed all but one of the observed predation events and prey sample locations off the Washington and Oregon coasts. We selected Cape Mendocino, California as the boundary between Areas 4 and 5 instead of Horse Mountain just to the south because the three predation events observed in California occurred off the Eel River just north of Cape Mendocino, and that boundary better demarcated the southern extent of a higher-use area based on the duration-of-occurrence model of satellite-tagged whale movements (Hanson *et al.* 2017).

The mouths of salmon-producing rivers likely provide locations with higher density of salmon as they return seasonally. For each specific area, we identified the adjacent fresh water system to which salmon return to spawn as indicators of essential feature presence, even in the absence of observed Southern Resident foraging behavior. Shelton *et al.* (2018) described distribution of fall Chinook salmon runs that provides insight into habitat use by Southern Residents; however, additional analysis of spring Chinook and other salmon runs has not yet been completed.

Table 1. Southern Resident Killer Whale critical habitat specific area descriptions.

Area	Boundaries	Size[5]	Essential feature (primary feature in bold)
1 - Coastal Washington/Northern Oregon Inshore Area	U.S. ocean waters west of a line connecting Cape Flattery, Washington (48°23′10″ N/124°43′32″ W), Tatoosh Island, Washington (48°23′30″ N/124°44′12″ W), and Bonilla Point, British Columbia (48°35′30″ N/124°43′00″ W), from the U.S. international border with Canada south to Cape Meares (45°29′12″ N), between the 6.1-m and 50-m isobath contours.	1,437.9 mi^2 (3,724.2 km^2)	**Prey**, passage, water quality
2 - Coastal Washington/Northern Oregon Offshore Area	U.S. ocean waters west of a line connecting Cape Flattery, Washington (48°23′10″ N/124°43′32″ W), Tatoosh Island, Washington (48°23′30″ N/124°44′12″ W), and Bonilla Point, British Columbia (48°35′30″ N/124°43′00″ W), from the U.S. international border with Canada south to Cape Meares (45°29′12″ N), between the 50-m and 200-m isobath contours.	4,617.2 mi^2 (11,958.6 km^2)	**Prey**, passage, water quality
3 - Central/Southern Oregon Coast Area	Cape Meares (45°29′12″ N) south to the OR/CA border (42°00′00″ N), between the 6.1-m and 200-m isobath contours.	4,962.6 mi^2 (12,853.1 km^2)	**Passage**, prey, water quality
4 - Northern California Coast Area	OR/CA border (42°00′00″ N) south to Cape Mendocino, CA (40°26′19″ N), between the 6.1-m and 200-m isobath contours.	1,606.8 mi^2 (4,161.5 km^2)	**Prey**, passage, water quality
5 – North Central California Coast Area	Cape Mendocino, CA (40°26′19″ N) south to Pigeon Point, CA (37°11′00″ N), between the 6.1-m and 200-m isobath contours.	3,976.2 mi^2 (10,298.4 km^2)	**Passage**, prey, water quality
6 - Monterey Bay Area	Pigeon Point, CA (37°11′00″ N) south to Point Sur, CA (36°18′00″ N), between the 6.1-m and 200-m isobath contours.	709.7 mi^2 (1,838.2 km^2)	**Prey**, passage, water quality

[5] Revisions to area size from proposed are based on best available spatial data at the time of the final rule.

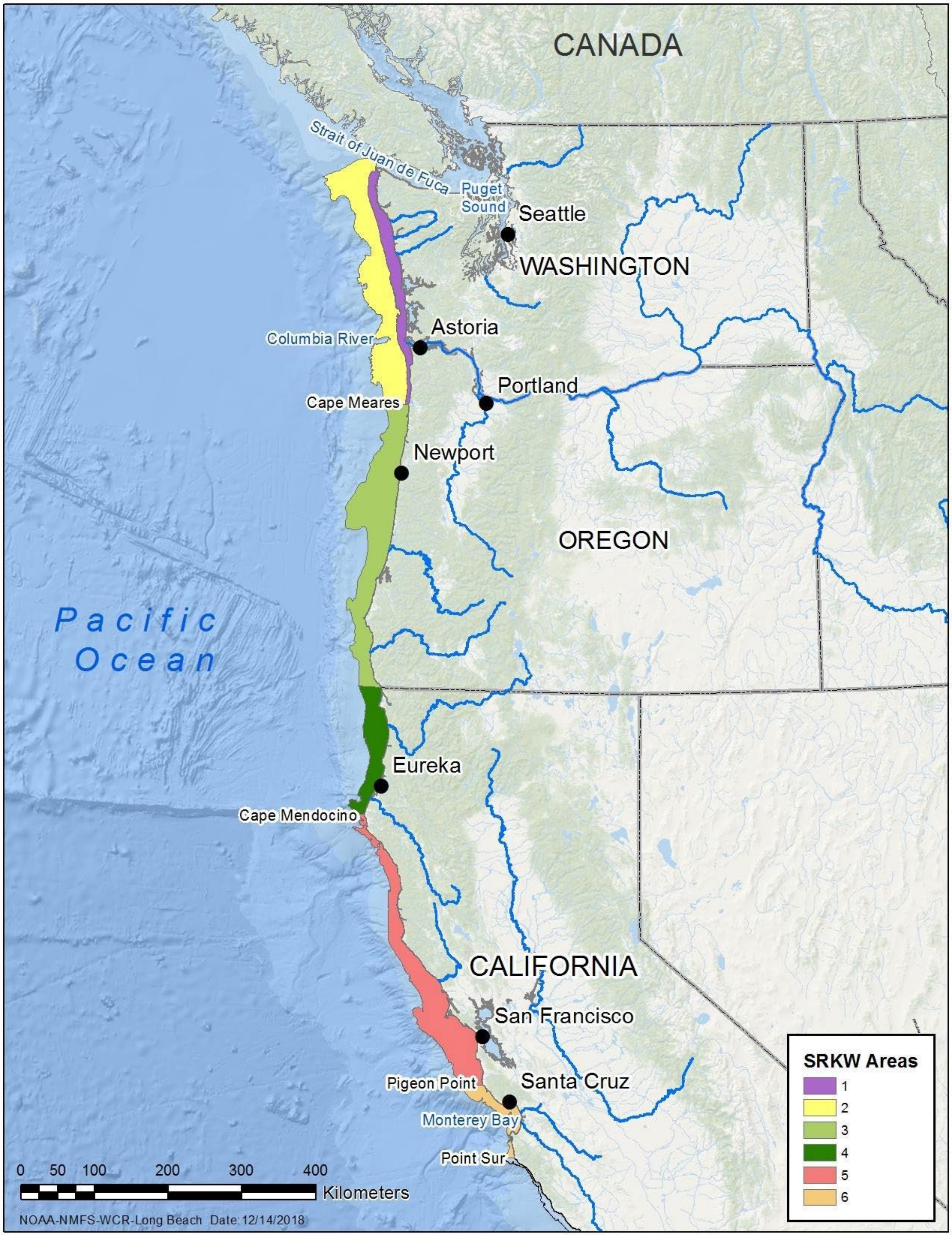

Figure 9. Specific areas containing essential habitat features.

A. Area 1 – Coastal Washington/Northern Oregon Inshore Area

Area 1 (Figure 10) is a Southern Resident killer whale high-use area, particularly for foraging, with documented consumption of essential prey sources. Prey is the primary essential feature of Area 1, but passage and water quality are also important features of high-use areas where foraging behaviors occur.

Areas 1 and 2 have the same northern and southern boundaries, but are separated longitudinally at the 50-m (164.0 ft) isobath due to differences in frequency of occurrence, movement patterns, and prey sampling, between nearshore and further offshore areas (see Figure 7). The 50-m isobath was selected because the majority (42 of 52, or 76.4%) of prey samples from observed Southern Resident killer whale predation events in these two areas were collected in water depths of 50 m or less, and just over half of the satellite tag locations in these two areas (54%) were in water depths of 50 m or less (NWFSC unpubl. data, Hanson *et al.* 2021).

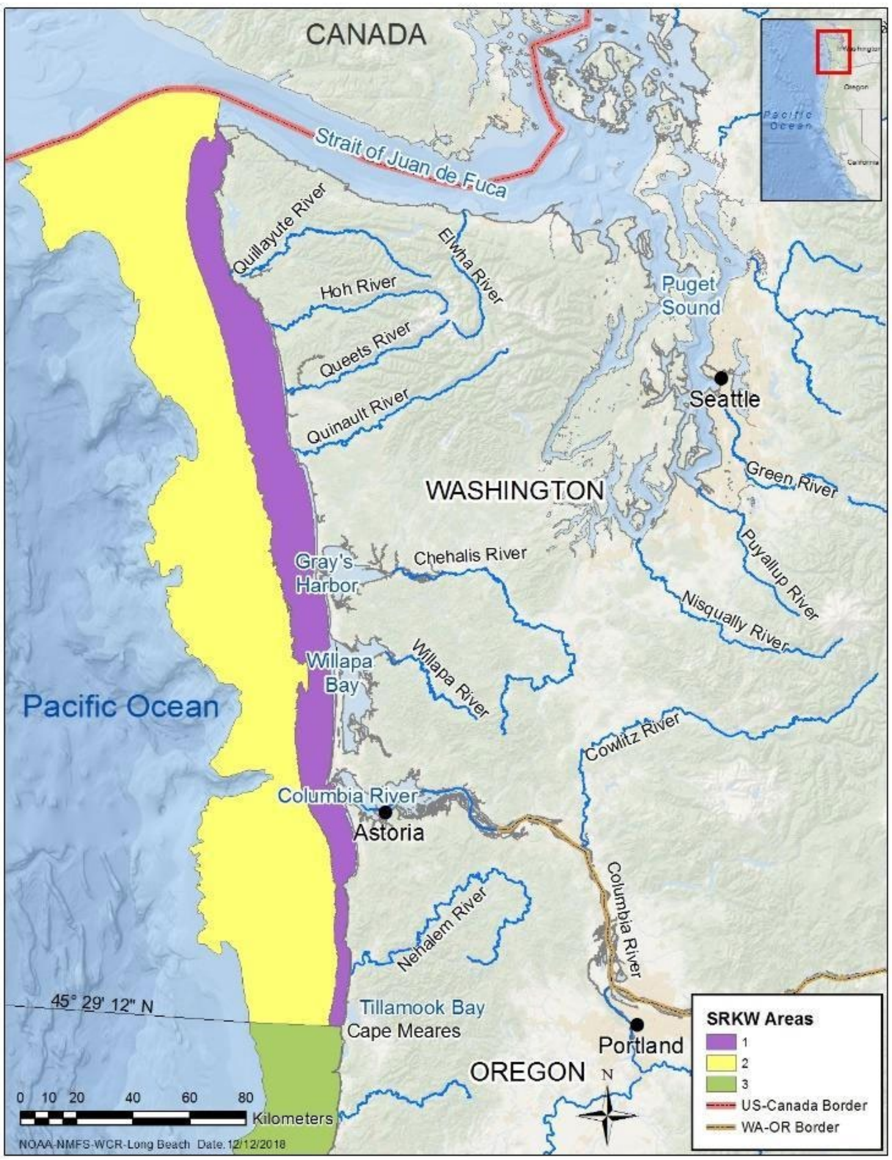

Figure 10. Map of Areas 1 and 2.

Numerous salmon stocks transit through Area 1 as they return to natal rivers and streams, and halibut and steelhead are known to be present year-round. Available information from fall run Chinook salmon – numerically the most abundant Chinook salmon along the U.S. West Coast – show that Areas 1 and 2 contain Chinook salmon from a diversity of natal regions from California to Canada. Results of a coast-wide state-space model for fall Chinook salmon developed by Shelton *et al.* (2018) suggest Areas 1 and 2 are relatively balanced in their composition of Chinook salmon, with fish originating in California, Oregon, the Columbia Basin, Puget Sound, and the Strait of Georgia all contributing at least 5% of the total Chinook salmon abundance. The largest contributions are from the Columbia Basin (seasonally >50%) and Puget Sound. This balanced diversity suggests that this area likely provides relatively stable and predictable numbers of total Chinook salmon through time as it is not particularly reliant on specific sources of fish (Shelton *et al.* 2018). Unfortunately, available information on Chinook salmon distributions does not distinguish between inshore and offshore areas, so differences in Chinook availability between Areas 1 and 2 cannot be described in more detail.

Analysis of the 42 Southern Resident killer whale prey samples collected in Area 1 identified 32 Chinook salmon, eight steelhead, one chum, and one halibut. The area of origin was identified for 25 of the Chinook salmon, most of which originated from area or river systems that include the Columbia River, Puget Sound, the Central Valley, and the Fraser River (Hanson *et al.* 2021).

Freshwater systems and estuarine areas adjacent to this area include the Strait of Juan de Fuca, the Queets, Hoh, Quillayute, Quinault, and Columbia rivers, Grays Harbor, Willapa Bay, and Tillamook Bay. Chinook originating from rivers adjacent to Areas 1 and 2 include nine of the top ten[6] priority Chinook populations identified as being important to the recovery of Southern Resident killer whales (NMFS & WDFW 2018).

Area 1 is considered a high-use area for Southern Residents based on J, K, and L pod presence documented through sightings, acoustic recordings, and satellite tag data. As described in section IV.B, satellite tagging data showed that J pod primarily stayed within the western end of the Strait of Juan de Fuca and the Salish Sea, but K and L pods used more outer coastal waters along Washington and Oregon, with their winter range beginning at the western entrance of the Strait of Juan de Fuca and expanding south (Figure 11).

[6] Top ten Chinook prey priorities are based on the populations with the ten largest total scores ("sum of factors") in the Southern Resident Killer Whale Priority Chinook Stocks Report NMFS and WDFW. 2018. Southern Resident killer whale priority Chinook stocks report. 8 pp. Retrieved from https://www.westcoast.fisheries.noaa.gov/publications/protected_species/marine_mammals/killer_whales/recovery/srkw_priority_chinook_stocks_conceptual_model_report___list_22june2018.pdf. Populations with the same (tied) total scores are considered to be the same priority, so the "top ten" discussed here actually include 19 populations. Scores and priority rankings are expected to change in the future as new data become available.

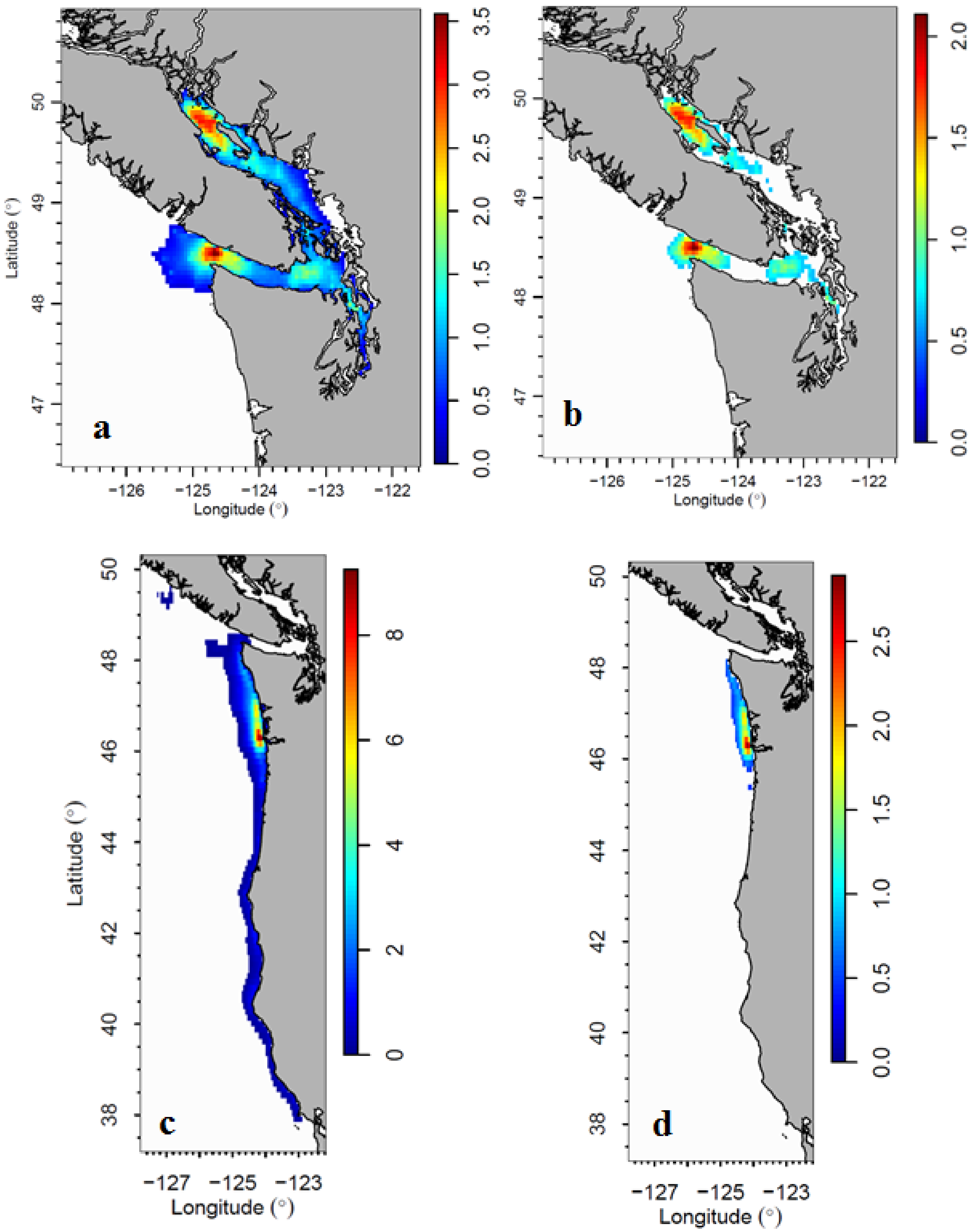

Figure 11. Highest 90% (**a**) and 50% (**b**) posterior density location plots of J pod, and highest 90% (**c**) and 50% (**d**) posterior density location plots of K/L pods, based on a Bayesian state-space movement model fit to satellite tag data. The color scale is relative to a uniform distribution within the colored area and is the dimensionless likelihood of being in a particular cell (from Hanson et al. 2017).

From 1982-2016, there were 49 confirmed opportunistic sightings of Southern Resident killer whales in U.S. outer coastal waters (excluding those in inside waters of Washington, those in inside or outer coastal waters of Canada, and the single sighting in Alaska; sightings of Southern Resident killer whales have been confirmed in inside waters as early as 1975) (see Appendix A). Three of these occurred in Area 1 and an additional 11 occurred in either in Area 1 or 2 (exact locations could not be determined). Sightings and encounters off the Washington coast occurred in February-April and June-October. These include the earliest confirmed sightings of Southern Residents along the U.S. West Coast (from the 1980s), as well as nearly annual (or more frequent) sightings since 2002. Here and in the area-specific sections below, these opportunistic sightings inform our understanding of where and when whales occur along the coast. However, the data by themselves are less useful for comparing across the six areas, given potential biases in the data collection (e.g., spatial bias in effort due to locations of population centers or routine whale watching operations, temporal bias in effort due to weather conditions).

Acoustic recorders off the Washington outer coast have detected Southern Resident killer whales in all months of the year (Hanson *et al.* 2013, Hanson *et al.* 2017, Emmons *et al.* 2021). An analysis of data through 2011 found that the numbers of observed detections of Southern Residents on acoustic recorders near Cape Flattery (inshore), Westport, and the Columbia River were higher than expected for the locations, given the amount of monitoring effort there (Hanson *et al.* 2013). This indicates these are likely biologically important areas and hotspots of Southern Resident killer whale use. The recorders have an estimated 5-mi (8-km) detection range and, based on their locations, may be detecting whales in either Area 1 or Area 2. The number of detections was lower than expected for the Cape Flattery offshore recorder located near the continental shelf break in Area 2, but the differences between the two Cape Flattery recorders were not statistically significant (Hanson *et al.* 2013).

Satellite tag data indicated K and L pods utilized the entire Washington outer coast from January-May, an area that represents only 16.2% of the total area they used, but where the whales spent 53.1% of their time. The area between Grays Harbor and the Columbia River is the area of highest concentrated use (Hanson *et al.* 2017). Tagged whales traveled more slowly off the northern and southern portions of the Washington coast (mean of the median speed of all tagged whales 6.0 and 6.1 km/hr [3.7 and 3.8 mi/hr], respectively) compared to when they were off Oregon and California (7.2 km/hr [4.5 mi/hr]) (Hanson *et al.* 2017). Slower travel speeds may be associated with foraging activities. Tagged whales moved within a broader north-south corridor off the Washington outer coast (~75% of locations occurred in a 17-km [10.6-mi] wide band that was 3-20 km [1.9-12.4 mi] offshore) compared to when they were off Oregon (10-km wide band [6.2 mi] 2-12 km [1.2-7.5 mi] offshore) or California (6-km [3.7 mi] wide band 2-8 km [1.2-5.0 mi] offshore) (Hanson *et al.* 2017). Based on tagging data, the median depth of waters used by the whales in Area 1 was 32 m (105 ft), and median distance from shore 7.2 km (4.5 mi) (NWFSC unpubl. data; see Figure 12 and Figure 13).

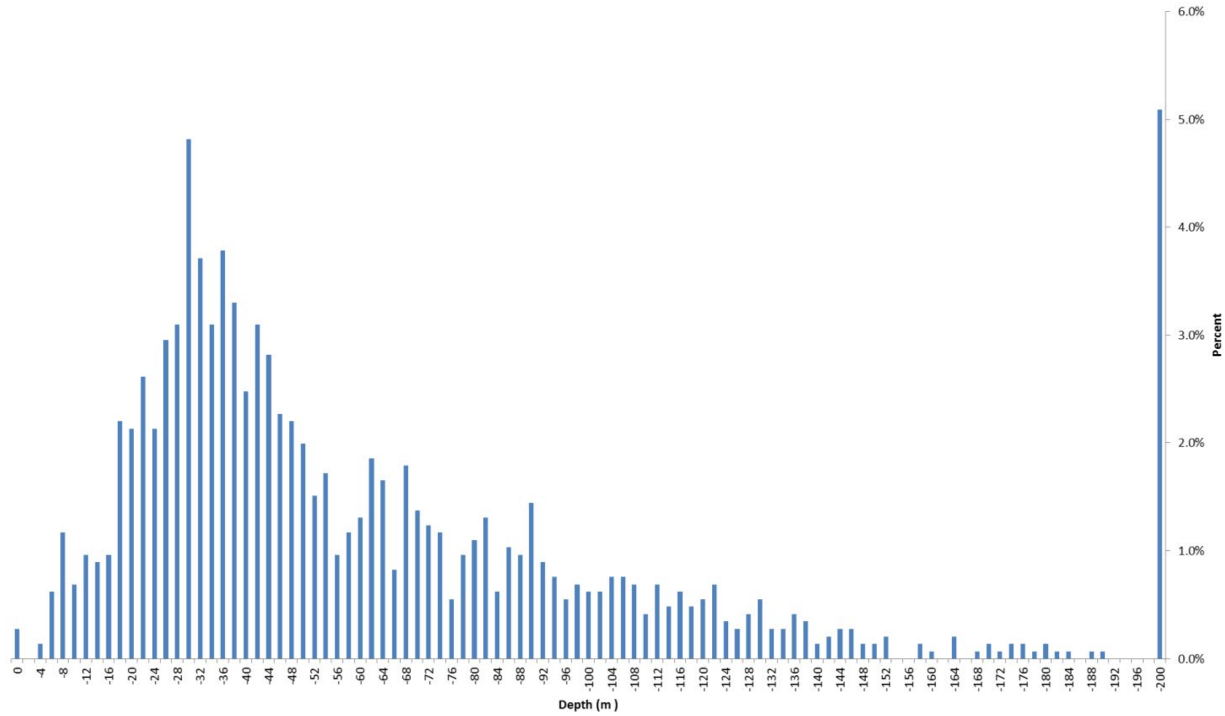

Figure 12. Distribution of depths (m) of waters used by 4 satellite-tagged K & L pod whales in Areas 1 & 2 (n=1458 locations). Tag locations were filtered with the Douglas Argos-Filter (available at: http://alaska.usgs.gov/science/biology/spatial/douglas.html) based on maximum potential velocity and turning angle.

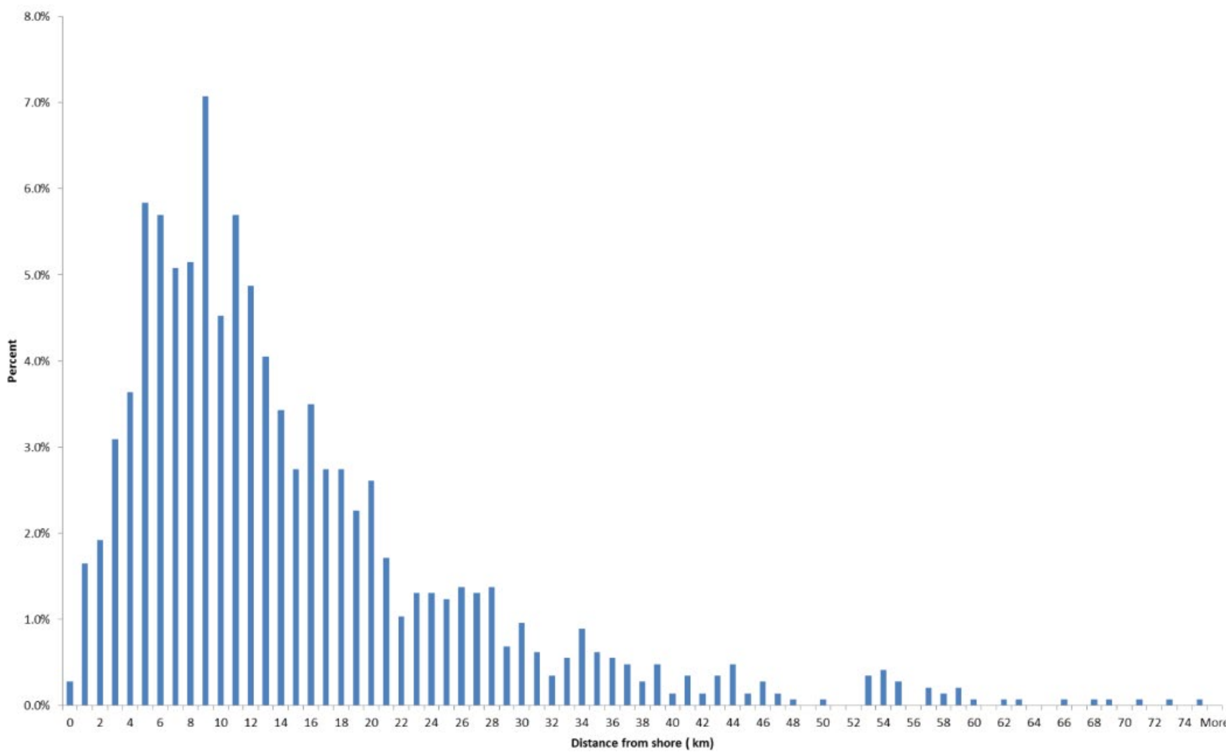

Figure 13. Distribution of distances from shore (km) of waters used by 4 satellite-tagged K & L pod whales in Areas 1 & 2 (n=1458 locations). Tag locations were filtered with the Douglas Argos-Filter.

B. Area 2 – Coastal Washington/Northern Oregon Offshore Area

Area 2 (Figure 10) is a Southern Resident killer whale high-use area (though less than Area 1, see Figure 7), particularly for foraging, with documented consumption of essential prey resources. Like Area 1, prey is the primary essential feature of Area 2 (although there were fewer prey samples collected in Area 2), while passage and water quality are also important features of high-use areas where foraging behaviors occur.

Information in the Area 1 discussion above (section VI.A) regarding salmon stock distribution and composition, adjacent freshwater and estuarine systems, and priority Chinook populations is also applicable to Area 2. As noted above, the balanced diversity of Chinook suggests that this area likely provides relatively stable and predictable numbers of total Chinook salmon through time as it is not particularly reliant on specific sources of fish (Shelton *et al.* 2018). Analysis of the 9 Southern Resident killer whale prey samples collected in Area 2 identified eight Chinook and one steelhead. The area of origin was identified for five of the Chinook, most of which originated from area or river systems that include the Columbia River and Central Valley (Hanson *et al.* 2021).

Area 2 is considered a high-use area for Southern Residents based on J, K, and L pod presence in this area documented through sightings, acoustic detections, and satellite tag data. From 1982-2016, of the 49 confirmed opportunistic sightings of Southern Resident killer whales in U.S. outer coastal waters, 12 occurred in Area 2, and an additional 11 occurred in either in Area 1 or 2 (exact location could not be determined). Sightings and encounters off the Washington coast occurred in February-April and June-October.

Information in the Area 1 discussion above (section VI.A) regarding acoustic detections of Southern Resident killer whales is also applicable to Area 2. Acoustic recorders off the Washington outer coast have detected Southern Resident killer whales in all months of the year (Hanson *et al.* 2013, Hanson *et al.* 2017, Emmons *et al.* 2021). An analysis of data through 2011 found that the number of observed detections on acoustic recorders near Cape Flattery (inshore), Westport, and the Columbia River was higher than expected for the locations, given the amount of monitoring effort there (Hanson *et al.* 2013). This indicates these are likely biologically important areas and hotspots of Southern Resident killer whale use. These recorders have an estimated 5-mi (8-km) detection range and, based on their locations, may be detecting whales in either Area 1 or Area 2. The number of detections was lower than expected for the Cape Flattery offshore recorder located near the continental shelf break in Area 2, but the differences between the two Cape Flattery recorders (inshore and offshore) were not statistically significant (Hanson *et al.* 2013).

Information in the Area 1 discussion above (section VI.A) regarding movements of Southern Resident killer whales (e.g., amount of time, speed and width of travel corridor) from satellite tag data is also applicable to Area 2, although there are different patterns in density of visitations (Figure 7). Based on tagging data, the median depth of waters used by Southern Residents in

Area 2 was 88 m (288.7 ft), and median distance from shore 19.4 km (12.1 mi) (NWFSC unpubl. data, see Figure 12 and Figure 13).

C. Area 3 – Central/Southern Oregon Coast Area

Area 3 (Figure 14) is an important corridor between Areas 1 and 2 and Area 4 feeding areas, such that passage is the primary habitat feature identified in this area. While foraging may be occurring, it has rarely been observed in Area 3 despite dedicated monitoring for predation. The majority of activity observed in Area 3 is travel. In addition to passage between feeding areas, known presence of prey resources and potential risks to water quality, prey and water quality are also identified as habitat features in this area.

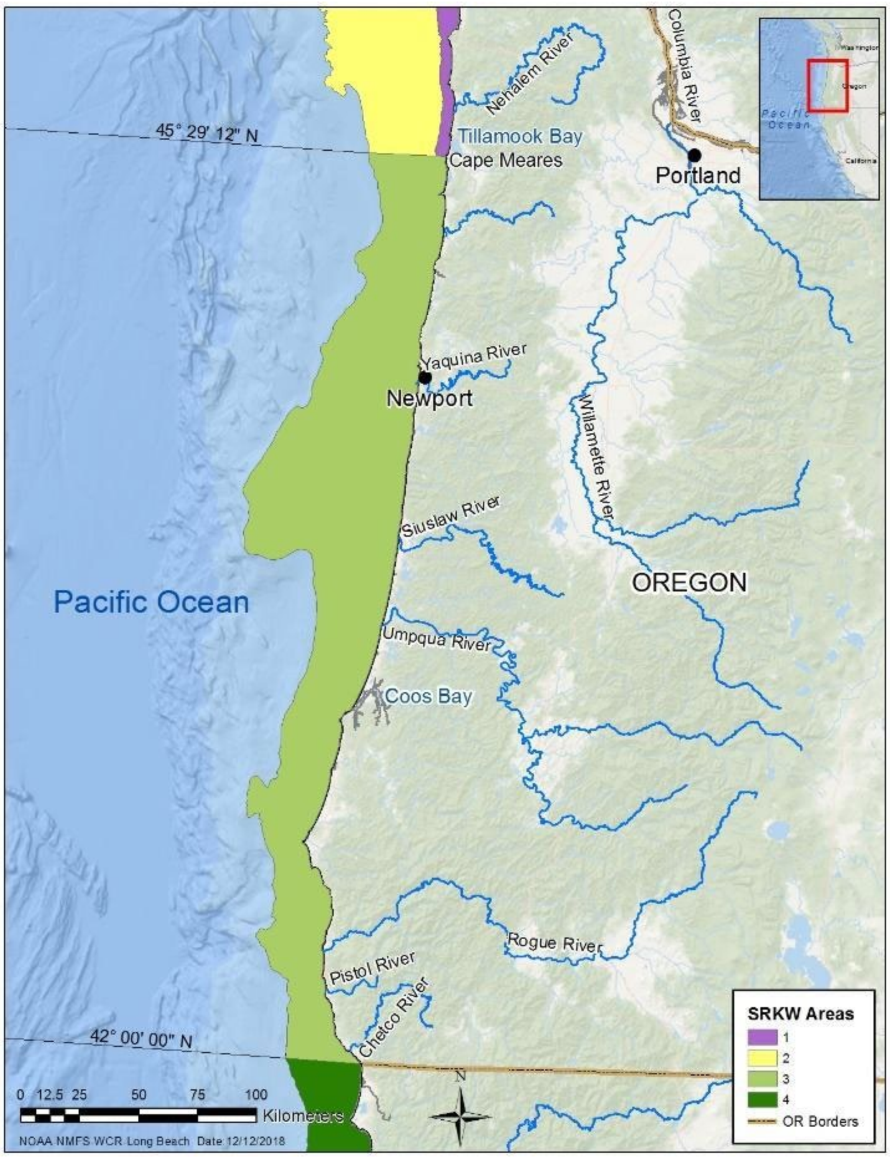

Figure 14. Map of Area 3.

Available evidence suggests fall Chinook salmon in Area 3 are predominantly from California and Oregon rivers with a lesser contribution from the Columbia drainage (Shelton *et al.* 2018). Chinook salmon originating from the Washington outer coast, Puget Sound, and Canada are rare in this area. Fish originating in the Columbia drainage are more common during the winter and spring than during the summer and fall. Overall abundances of fall Chinook salmon in this region are thought to be roughly comparable to abundances along the Washington coast (Areas 1 and 2) (Shelton et al. 2018). Detailed analysis of spring Chinook salmon have not yet been completed and may improve our understanding of Southern Resident use of this area.

Only one Southern Resident killer whale prey sample has been collected from Area 3, just south of the boundary with Area 2 during a multi-day encounter (following a satellite-tagged whale) that spanned Areas 1-3. The sample from Area 3 was identified as a Chinook originating from the Klamath River (Hanson *et al.* 2013). Additionally, an attempted predation event was observed in January 2013 off Coos Bay, Oregon, with two whales seen chasing a salmon near the surface (NWFSC unpubl. data).

Freshwater systems used by salmon adjacent to this area including the Yaquina, Suislaw, Umpqua, Coos, Rogue, Pistol, and Chetco rivers. None of the Chinook originating from rivers adjacent to Area 3 are considered to be in the top ten priority Chinook populations identified as being important to the recovery of Southern Resident killer whales (NMFS & WDFW 2018), largely because these populations have not been identified through prey tissue/scales or fecal samples to be an observed part of the Southern Residents' diet.

Only K and L pod have been documented to use Area 3 based on sightings, acoustic detections, and satellite tag data. From 1982-2016, of the 49 confirmed opportunistic sightings of Southern Resident killer whales in U.S. outer coastal waters, eight occurred in Area 3, in January-May. Most of these occurred from 2009-2013.

An acoustic recorder located off Newport, Oregon detected Southern Resident killer whales in January-March and May (Hanson *et al.* 2013). An analysis of this recorder's data through 2011 indicated the number of observed detections was much lower than expected given the amount of monitoring effort there (Hanson *et al.* 2013), suggesting the whales use Area 3 primarily for transiting. Another recorder more recently deployed off Brookings, Oregon, near the border between Oregon and California (and the border between Areas 3 and 4) detected Southern Resident killer whales in January, March, and December (NWFSC unpubl. data).

Satellite-tagged whales moved through the area from January through March (NWFSC unpubl. data). Tagged whales moved within a narrower north-south corridor off the Oregon coast (~75% of locations occurred in a 10-km [6.2 mi] wide band that was 2-12 km [1.2-7.5 mi] offshore) compared to when they were off the Washington coast (17-km [10.6-mi] wide band that was 3-20 km [1.9-12.4 mi] offshore) (Hanson *et al.* 2017). Based on tagging data, the median depth of waters used by Southern Residents in Area 3 is 57 m (187 ft), and average distance from shore is 6 km (3.7 mi) (NWFSC unpubl. data; see Figure 15 and Figure 16). The tagged whales' median travel speeds were also faster off the coasts of Oregon and California (7.2 km/hr [4.5 mi/hr]) compared to their speeds off the northern and southern coasts of Washington (6.0 and 6.1 km/hr [3.7 and 3.8 mi/hr], respectively) (Hanson et al. 2017). Faster travel speeds may indicate directed transiting and less time spent searching for prey or feeding.

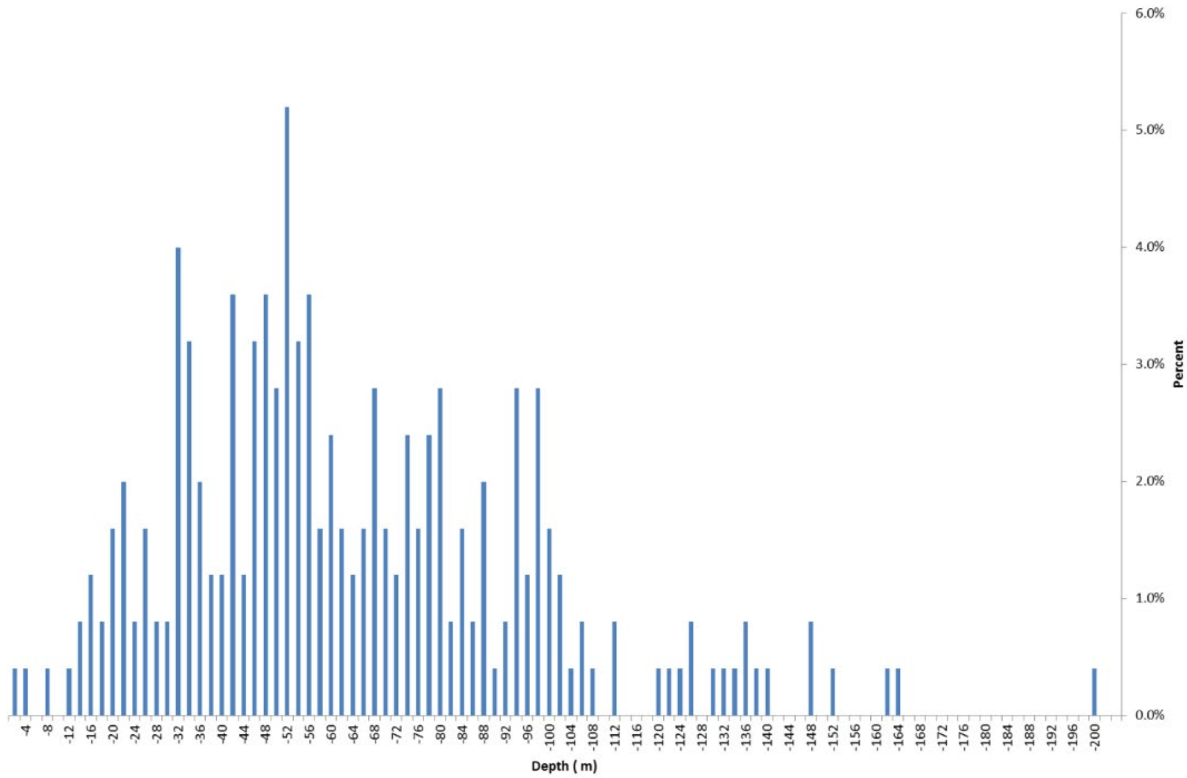

Figure 15. Distribution of depths (m) of waters used by 4 satellite-tagged K & L pod whales in Area 3 (n=251 locations). Tag locations were filtered with the Douglas Argos-Filter.

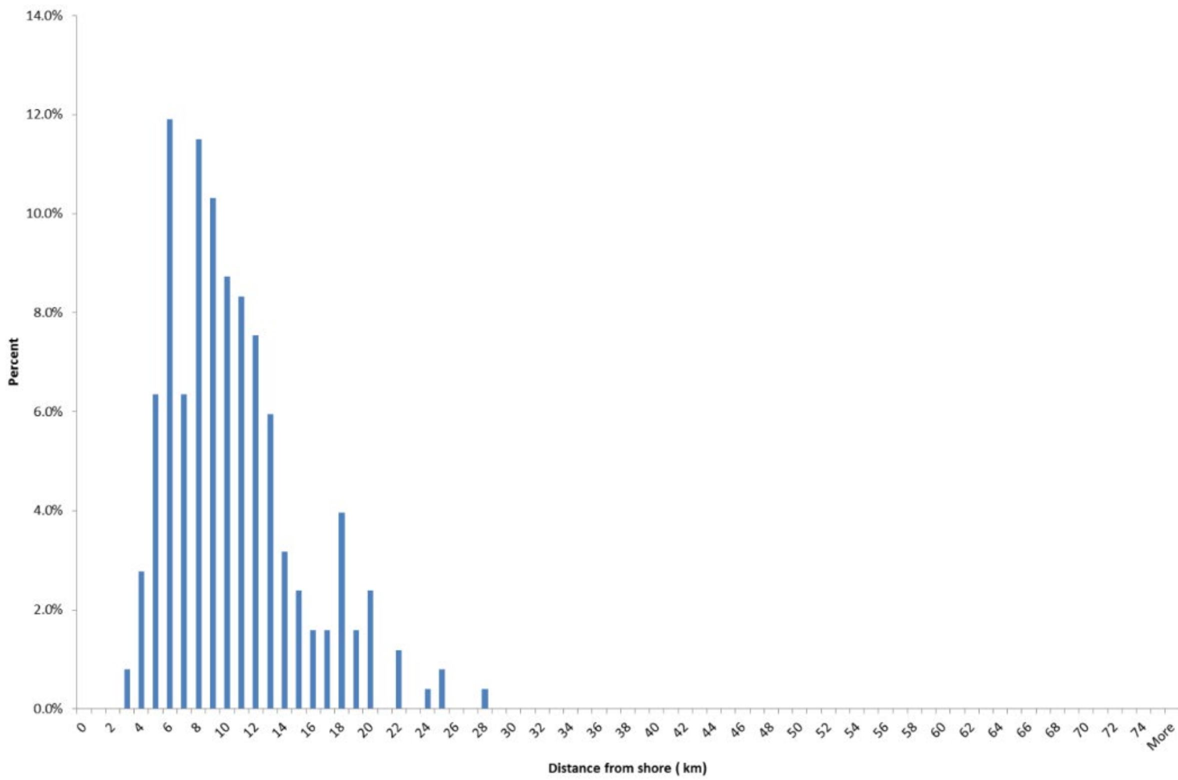

Figure 16. Distribution of distances from shore (km) of waters used by 4 satellite-tagged K & L pod whales in Area 3 (n=251 locations). Tag locations were filtered with the Douglas Argos-Filter.

D. Area 4 – Northern California Coast Area

Area 4 (Figure 17) is an important feeding habitat for Southern Residents and for the prey resources. Prey is the primary essential feature of Area 4, but passage and water quality are also important features in areas where Southern Resident killer whales are foraging.

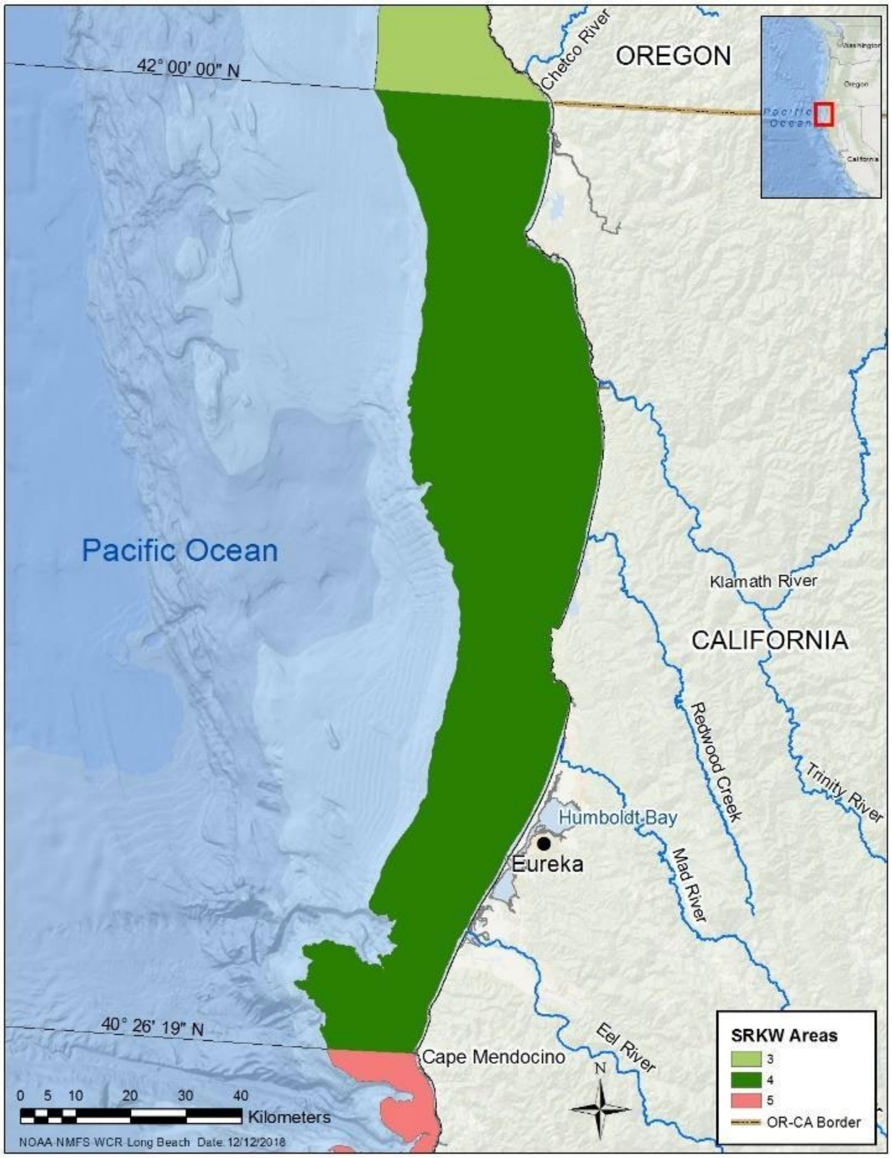

Figure 17. Map of Area 4.

California fall Chinook stocks—predominantly from the Klamath River and California Central Valley—comprise approximately 50% of the total fall Chinook salmon available in this region, with southern Oregon rivers comprising a large portion of the remaining fish (Shelton *et al.* 2018). Columbia River basin fish provide a small proportion of fall Chinook but virtually no fish from Washington or areas further north are present in this area (Shelton *et al.* 2018). The three prey samples collected near foraging whales in Area 4 were identified as Chinook salmon from the Central Valley spring and fall runs (Hanson et al. 2021).

Freshwater systems adjacent to this area that salmon are known to utilize include the Klamath, Mad, and Eel Rivers and Redwood Creek. Chinook originating from rivers adjacent to Area 4 include two of the top ten priority Chinook populations identified as being important to the recovery of Southern Resident killer whales (NMFS & WDFW 2018).

K and L pod have been documented using Area 4 through sightings and satellite tag data; no acoustic recorders were located in this area. From 1982-2016, of the 49 confirmed opportunistic sightings of Southern Resident killer whales in U.S. outer coastal waters, only one relatively recent (2014) sighting occurred in Area 4, in April.

Satellite-tagged whales spent time in Area 4 in January through April (NWFSC unpubl. data). As described in previous sections, tagged whales swam within a relatively narrow north-south corridor off the coast of California compared to when they were off the coasts of Washington or Oregon (Hanson *et al.* 2017). The median depth of waters used by Southern Residents in Area 4 was 45 m (147.6 ft) and median distance from shore is 6.3 km (3.9 mi) (NWFSC unpubl. data; see Figure 18 and Figure 19). The tagged whales' median swim speeds were also faster off Oregon and California compared to off the Washington coast (Hanson *et al.* 2017).

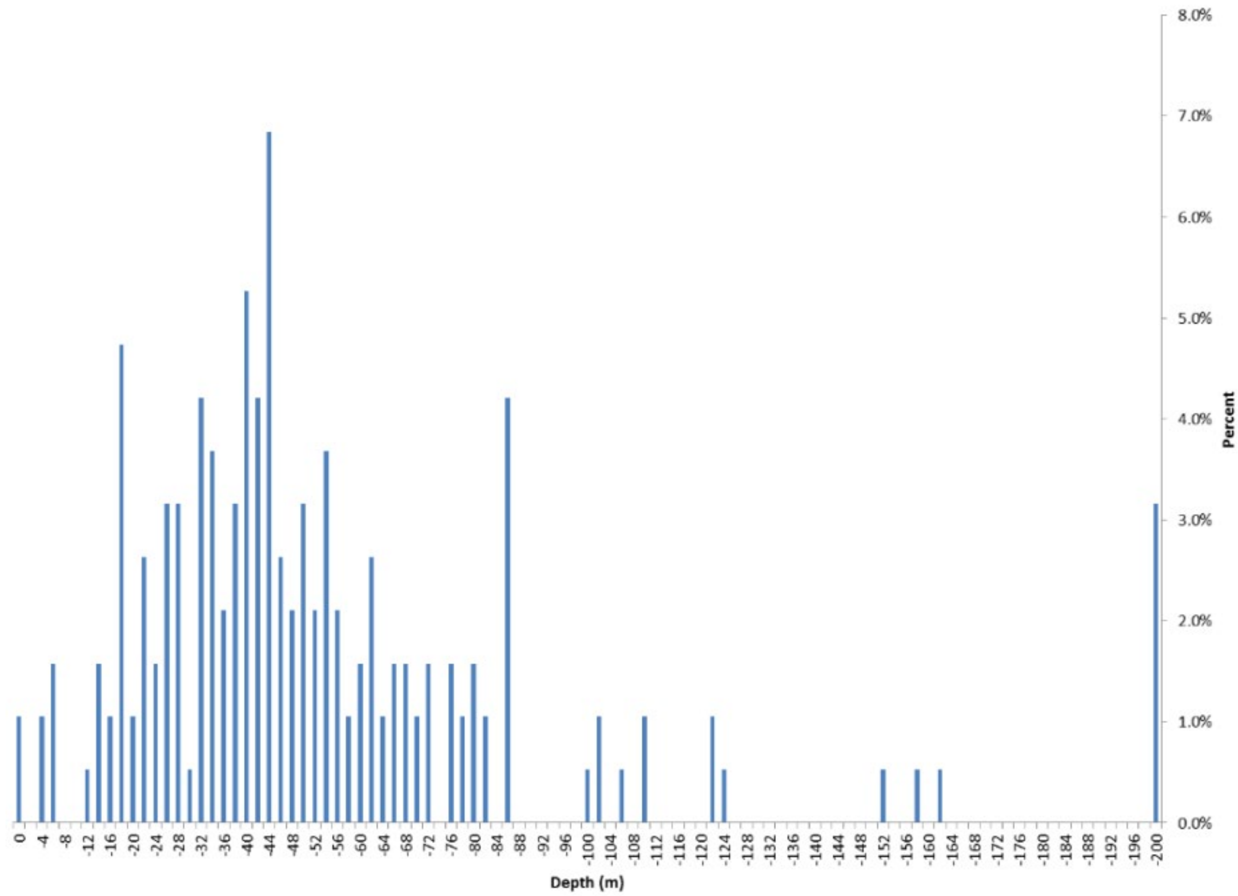

Figure 18. Distribution of depths (m) of waters used by 4 satellite-tagged K & L pod whales in Area 4 (n=194 locations). Tag locations were filtered with the Douglas Argos-Filter.

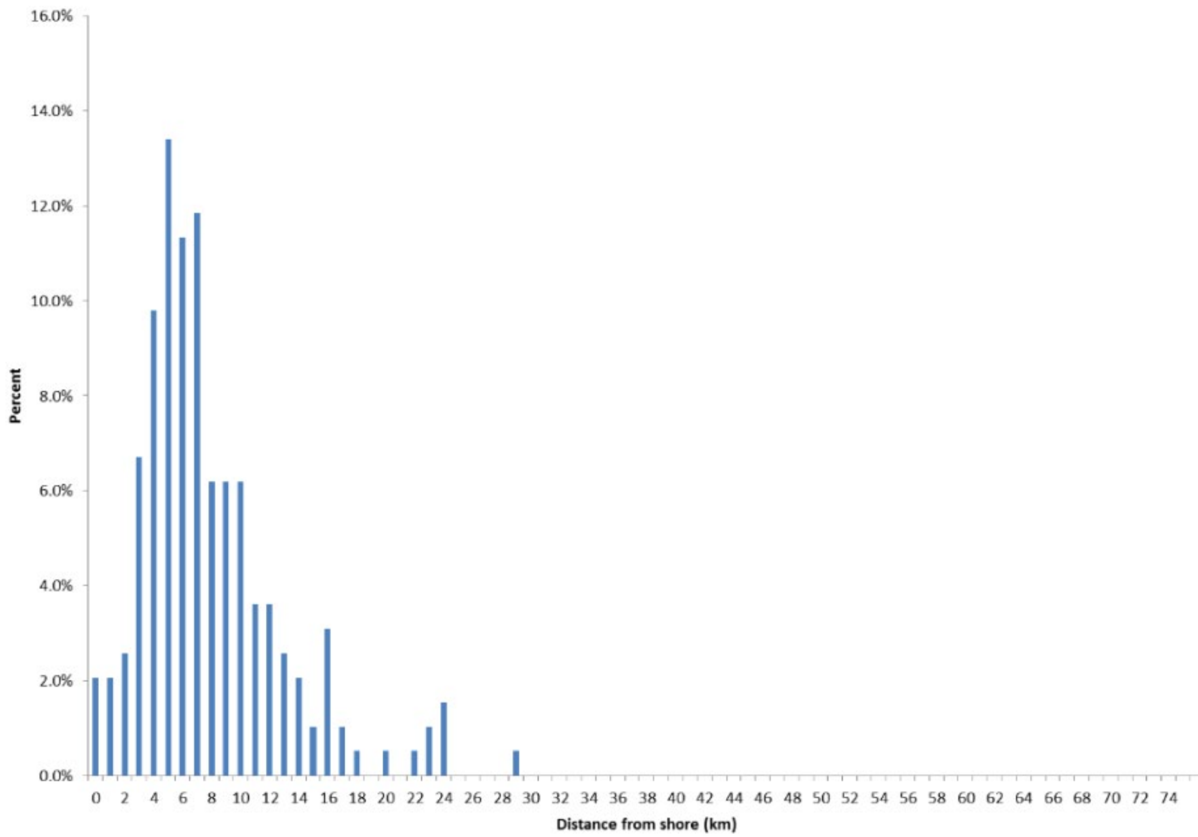

Figure 19. Distribution of distances from shore (km) of waters used by 4 satellite-tagged K & L pod whales in Area 4 (n=194 locations). Tag locations were filtered with the Douglas Argos-Filter.

E. Area 5 – North Central California Coast Area

Area 5 (Figure 20) is an important corridor between the Area 4 and Area 6 feeding areas, such that passage is the primary habitat feature identified in this area. Foraging may be occurring in Area 5, but it has not been observed despite dedicated monitoring for predation. Since prey species are known to occur here, the prey feature is included for this area.

Given the presence of prey resources and potential for oil spills, water quality is also identified as a habitat feature in this area. As described in section III.F.2, high levels of DDTs have been found in Southern Resident killer whales, especially in K and L pods, which spend more time in California in the winter where DDTs still persist in the marine ecosystem (Sericano *et al.* 2014).

K and L pod have been documented to use Area 5 based on sightings, acoustic detections, and satellite tag data. From 1982-2016, of the 49 confirmed opportunistic sightings of Southern Resident killer whales in U.S. outer coastal waters, seven of these occurred in Area 5 in January-March and October. These included nearly annual (or more frequent) sightings from 2005-2011.

Acoustic recorders located off Fort Bragg and Pt. Reyes, California detected the whales in January, February, May, and December; there were no detections on a recorder located off Sea Ranch, California (Hanson *et al.* 2013). Analysis of the numbers of observed detections on the Fort Bragg and Pt. Reyes recorders through 2011 were much lower than expected given the amount of monitoring effort there (Hanson *et al.* 2013), suggesting the whales use Area 5 primarily for transiting.

Figure 20. Map of Area 5.

Satellite-tagged whales moved through Area 5 in January and February (NWFSC unpubl. data). As described in previous sections, satellite-tagged whales swam within a relatively narrow north-south corridor off the coast of California compared to when they were off the coasts of Washington or Oregon (Hanson *et al.* 2017). The median depth of waters used by Southern Residents in Area 5 was 72.5 m (237.9 ft) and median distance from shore was 4.0 km (2.5 mi) (NWFSC unpubl. data; see Figure 21 and Figure 22). The tagged whales' median swim speeds were also faster off Oregon and California compared to off the Washington coast (Hanson *et al.* 2017).

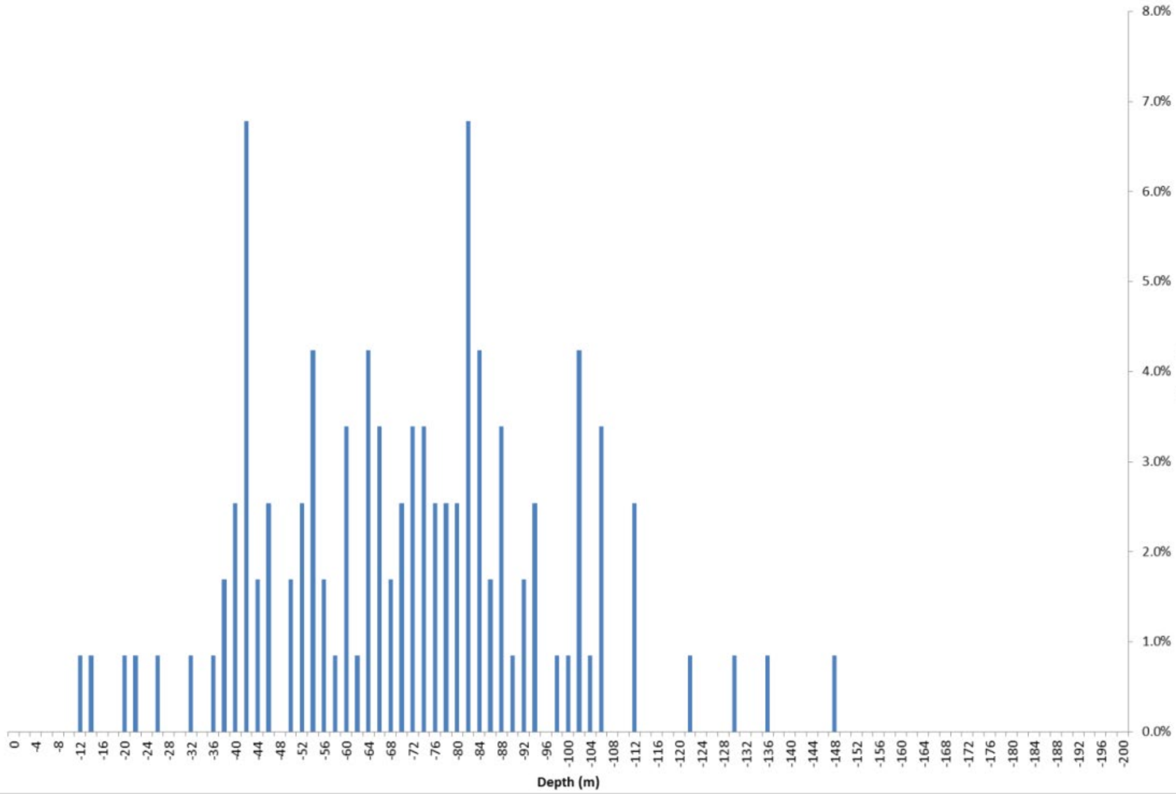

Figure 21. Distribution of depths (m) of waters used by 4 satellite-tagged K & L pod whales in Area 5 (n=120 locations). Tag locations were filtered with the Douglas Argos-Filter.

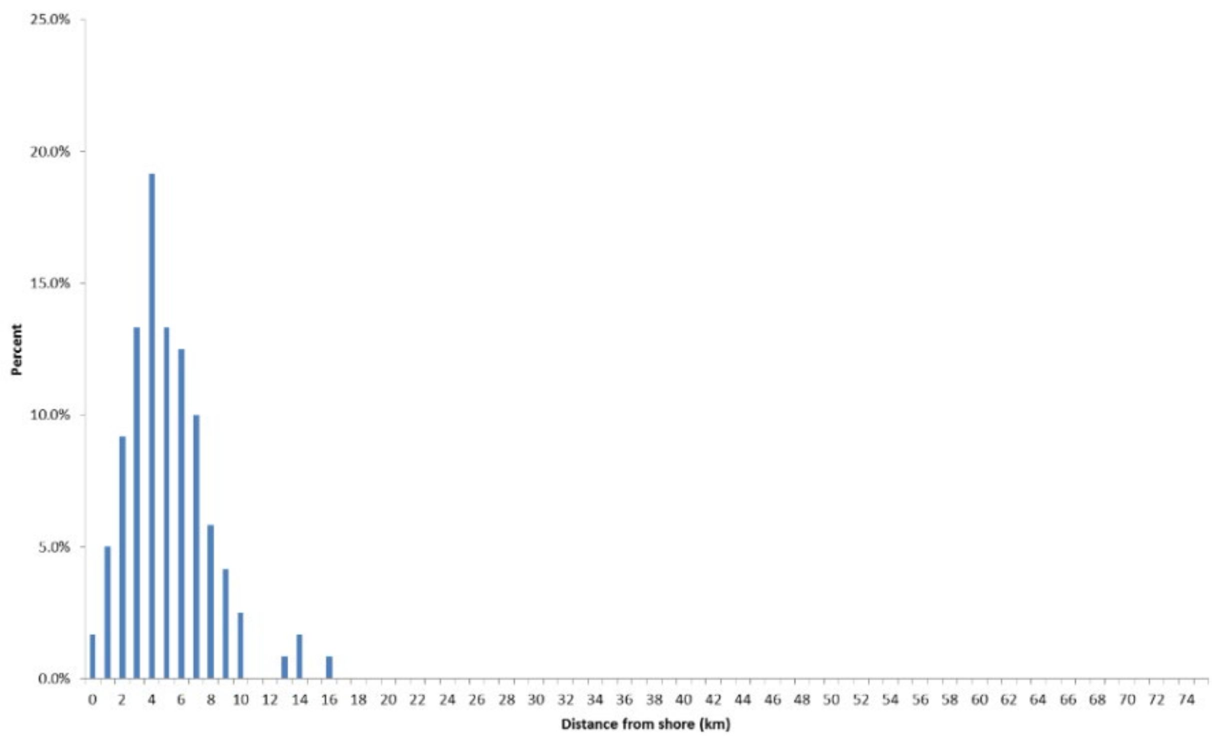

Figure 22. Distribution of distances from shore (km) of waters used by 4 satellite-tagged K & L pod whales in Area 5 (n=120 locations). Tag locations were filtered with the Douglas Argos-Filter.

F. Area 6 – Monterey Bay Area

Area 6 (Figure 23) is the southernmost feeding area for Southern Residents and contains essential prey resources. Individuals from K and L pod were observed foraging in Monterey Bay, California (observation by N. Black, Monterey Bay Whale Watch, Pacific Grove, CA, cited in Krahn *et al.* 2004). Prey is the primary essential feature of Area 6, but passage and water quality are also important features in areas where Southern Resident killer whales are foraging. Presence of some contaminants in the critical habitat areas in California is different from other coastal areas. As described in section III.F.2, high levels of DDTs have been found in Southern Resident killer whales, especially in K and L pods, which spend more time in California in the winter where DDTs still persist in the marine ecosystem (Sericano *et al.* 2014).

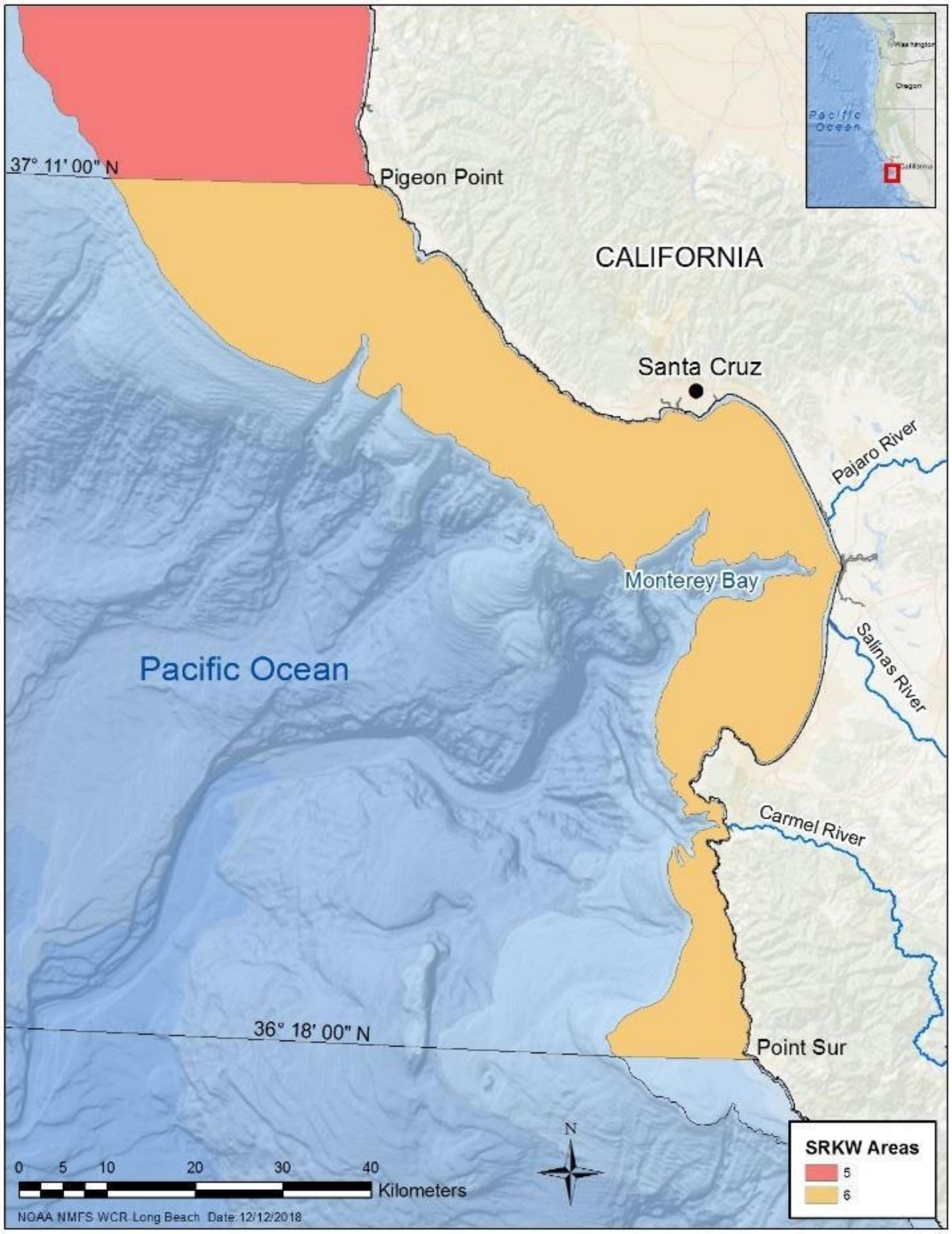

Figure 23. Map of Area 6.

There has been no prey sampling conducted in Area 6; however, the Salinas and Carmel Rivers are freshwater systems adjacent to the area where Chinook stocks may be present. None of the Chinook originating from rivers adjacent to Area 6 are considered to be in the top ten priority Chinook populations identified as being important to the recovery of Southern Resident killer whales (NMFS & WDFW 2018), but this is largely because these populations have not been identified through prey tissue/scales or fecal samples to be an observed part of the Southern Residents' diet.

Similar to Area 5, Area 6 is dominated by California fall Chinook stocks. Virtually all fall Chinook present in Area 6 arise from either the California Central Valley or from Klamath River.

In all seasons, between 50 and 75% of fish present are predicted to be from the Central Valley (Shelton *et al.* 2018). Additionally, the total abundance of fall Chinook is thought to be generally lower than more northern areas (Shelton *et al.* 2018).

K and L pod have been documented to use Area 6 based on sightings; no acoustic recorders were located in this area, and satellite-tagged whales did not travel farther south than Point Reyes in Area 5 (Hanson *et al.* 2017). From 1982-2016, of the 49 confirmed opportunistic sightings of Southern Resident killer whales in U.S. outer coastal waters, seven occurred in Area 6 in January-March. These included nearly annual (or more frequent) sightings from 2007-2011.

G. Comparison of Areas

Table 2 below summarizes the characteristics of the six coastal critical habitat areas in terms of when and how Southern Resident killer whales have been documented using the areas and the prey available in those areas.

Table 2. Comparison of characteristics and Southern Resident killer whale use of the six critical habitat areas.

		Area 1	Area 2	Area 3	Area 4	Area 5	Area 6
# Confirmed sightings		3 (+11 in Areas 1 or 2)	12 (+11 in Areas 1 or 2)	8	1	7	7
Pods		J, K, L	J, K, L	K, L	K, L	K, L	K, L
Months Used	**Sightings**	Feb-Apr (+Jun, Jul, Sept, Oct in Areas 1 or 2)	Feb-Apr, Jun, Aug (+ Jul, Sep, Oct in Areas 1 or 2)	Jan-May	Apr	Jan-Mar, Oct	Jan-Mar
	Acoustic detections	Jan-Dec	Jan-Dec	Jan-Mar, May, Dec	N/A (no recorders)	Jan-Feb, May	N/A (no recorders)
	Satellite tag locations	Jan-May	Jan-May	Jan-Mar	Jan-Mar	Jan-Feb	N/A (tagged animals did not use Area 6)
	Combined	Jan-Dec	Jan-Dec	Jan-May, Dec	Jan-Apr	Jan-Mar, May, Oct	Jan-Mar
Mvmt from satellite tags	**Median depth**	32 m	88 m	57 m	45 m	72.5 m	N/A (tagged animals did not use Area 6)
	Median dist. from shore	7.2 km	19.4 km	6 km	6.3 km	4.0 km	
	Travel corridor	3-20 km (WA outer coast)		2-12 km (Oregon coast)	2-8 km (CA coast)	2-8 km (CA coast)	
	Median travel speed	6.0 km/hr (northern WA) 6.1 km/hr (southern WA)		7.2 km/hr (Oregon coast)	7.2 km/hr (CA coast)	7.2 km/hr (CA coast)	
# Prey samples		43	10	1 (+ observed attempted predation)	3	0	0 (+ observed predation)
Stock ID of prey samples		• Chinook: o Central Valley Spring o Lower Columbia Fall o Lower Columbia Spring o Mid-Columbia Tule o Mid-Upper Columbia o Upper Columbia Summer/Fall o Mid-Fraser o Mid-Oregon Coast o North Puget Sound	• Chinook o Central Valley Spring o Lower Columbia Spring o Upper Columbia Summer/Fall • Steelhead	• Chinook o Klamath	• Chinook o Central Valley Spring o Central Valley Fall	N/A	N/A

	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6
	o South Puget Sound o Snake Spring/Summer o Taku o Upper Stikine • Steelhead • Chum • Halibut					
Overlap with fall run Chinook stocks	Relatively balanced composition originating in CA, OR, Columbia Basin, Puget Sound, Strait of Georgia, with largest contributions from Columbia Basin and Puget Sound		Predominantly from CA and OR rivers, lesser contribution from Columbia drainage. Chinook from WA coast, Puget Sound, and Canada are rare	Predominantly from Klamath River and CA Central Valley; also southern OR rivers, small numbers from Columbia	Virtually all from CA Central Valley or Klamath River	Virtually all from CA Central Valley or Klamath River
Priority Chinook populations originating from rivers adjacent to the area (those ID'd as top 10 priority populations in bold)[7]	• **Lower Columbia (fall)** • **Upper Columbia & Snake Fall (fall)** • **Lower Columbia (spring)** • **Middle Columbia (fall)** • **Snake River (spring-summer)** • **Washington Coast (spring)** • **Washington Coast (fall)** • **Middle & Upper Columbia Spring (spring)** • **Middle & Upper Columbia Summers (summer)** • Upper Willamette (spring)		• North & Central Oregon Coast (fall) • Southern Oregon & Northern California Coastal (fall) • Southern Oregon & Northern California Coastal (spring)	• **Klamath River (fall)** • **Klamath River (spring)** • Southern Oregon & Northern California Coastal (fall) • California coastal (fall) • California coastal (spring)	• **Central Valley (spring)** • **Central Valley (fall and late fall)** • Central Valley (winter)	

[7] Chinook prey priorities are from NMFS & WDFW 2018, June 22, 2018 version. Top ten priorities are based on the ten largest total scores ("sum of factors"). Because those with the same (tied) total scores are considered to be the same priority, the "top ten" actually include 19 populations. Scores and priority rankings are expected to change in the future as new data become available.

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VII. Special Management Considerations

The specific areas within the geographical area occupied by a species meet the definition of critical habitat only if they contain physical or biological features that "may require special management considerations or protection." Joint NMFS and USFWS regulations at 50 CFR 424.02(j) define "special management considerations or protection" to mean "any methods or procedures useful in protecting physical and biological features of the environment for the conservation of listed species."[8]

Human activities managed under a variety of legal mandates have the potential to affect the habitat features essential to the conservation of Southern Resident killer whales, including those that could increase water contamination and/or chemical exposure, decrease the quantity, quality, or availability of prey, or could inhibit safe, unrestricted passage between important habitat areas to find prey and fulfill other life history requirements. Examples of these types of activities include (but are not limited to), in no particular order: (1) salmon fisheries and bycatch; (2) salmon hatcheries; (3) offshore aquaculture/mariculture; (4) alternative energy development; (5) oil spills and response; (6) military activities; (7) vessel traffic; (8) dredging and dredge material disposal; (9) oil and gas exploration and production; (10) mineral mining (including sand and gravel mining); (11) geologic surveys (including seismic surveys); and (12) activities occurring adjacent to or upstream of critical habitat that may affect essential features, labeled "upstream activities" (including activities contributing to point-source water pollution, power plant operations, liquefied natural gas terminals, desalinization plants). These activities were identified based on NMFS' ESA section 7 consultation history since 2006 for existing critical habitat, along with additional information that has become available since the original designation.

Below we describe the categories of activity and their potential effects on the essential habitat features in areas we include in the new critical habitat designation. This is not an exhaustive or complete list of potential activities, rather these activities are of primary concern because of their potential effects that we are aware of at this time and that should be considered in accordance with section 7 of the ESA when federal agencies authorize, fund, or carry out these activities. The ESA section 7 requirement that federal agencies ensure their actions are not likely to adversely modify critical habitat applies not only to actions occurring within designated critical habitat, but also to actions occurring outside of designated areas which can impact the features of the critical habitat. For example consultation could be required on activities that occur in waters shallower than 20 feet (6.1 m) or in upstream freshwater locations if those actions are likely to adversely affect essential habitat features in designated critical habitat (labeled "upstream activities" below). The activities are not presented in any rank order and activities that could be regulated in the future are included. We provide overviews of the activities here and further description is provided in the Final Economic Report (IEc 2021) and the Final ESA Section 4(b)(2) Report (NMFS 2021a). This discussion does not include activities within or adjacent to

[8] The proposed and final rules to revise critical habitat for Southern Resident killer whales follow previous ESA implementing regulations, as the most recent revisions to the implementing regulations, which became effective on September 26, 2019, only apply to classification and critical habitat rules for which a proposed rule was published after September 26, 2019 (see 84 FR 45020; August 27, 2019). The proposed rule for the revision to Southern Resident killer whale critical habitat (84 FR 49214) was published on September 19, 2019.

inland critical habitat in inland waters of Washington, including Puget Sound, as they were previously addressed in the original critical habitat designation and consultations already occur for these activities based on existing Southern Resident killer whale critical habitat. Following the general discussion of activities and the consideration of procedures in place to protect environmental features, we provide Area-specific information, where available, on the activities in section VII.B.

A. Activities That May Require Special Management Considerations

A.1. Salmon fisheries & bycatch

Directed and incidental fishing activities may reduce the biomass available to Southern Resident killer whales by removing prey or by selecting for the larger salmon that are preferred by Southern Resident killer whales (NMFS 2008a). Below we describe directed salmon fisheries as well as other fisheries that may take salmon as bycatch, including those targeting Pacific groundfish and coastal pelagic species.

A.1.a. Salmon fisheries

Pacific salmon fisheries provide for commercial, recreational, and tribal harvest in ocean and inland waters. The broad geographic range and migration routes of salmon, from the inland tributaries to offshore areas, require comprehensive management by multiple entities, domestic and international.

Salmon stocks that migrate through international waters are managed under the 1985 Pacific Salmon Treaty, which includes chapters addressing the management of salmon species and fisheries in transboundary rivers. The U.S. and Canadian governments work with tribes, states, and sport and commercial fishing groups to provide for shared conservation and harvest objectives under the purview of the Treaty. Chapters addressing the management of Chinook, coho, and other species were most recently renegotiated in 2018, effective until 2028. The Treaty governs fisheries that overlap in time and space with the whales, including fisheries off Canada and the U.S. West Coast. Additionally, the Treaty addresses salmon fisheries in Alaska and Canada that do not overlap in time and space with the whales but do affect the amount of salmon returning to waters off Canada and the U.S. that are inhabited by the whales. Because the Southeast Alaska salmon fisheries may reduce prey available to Southern Residents, NMFS has consulted on impacts from these fisheries to the whales and their prey (NMFS 2019)

Salmon fisheries in U.S. marine waters between 3-200 miles (4.8 to 321.9 km) off the coast are managed domestically under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), consistent with the Pacific Salmon Treaty. The MSA authorizes regional fishery management councils to develop and submit fishery management plans (FMPs) and associated amendments to the Secretary of Commerce for each regional fishery that requires conservation and management. Salmon fisheries off Southeast Alaska are addressed by the North Pacific Fishery Management Council’s Salmon Fishery Management Plan, which largely delegates management to the State of Alaska. Off the U.S. West Coast, the Pacific Fishery Management Council (PFMC) and NMFS manage ocean salmon fisheries under the Pacific Coast Salmon Fishery Management Plan (FMP). Ocean salmon fisheries result in catch of a mix of salmon stocks, primarily Chinook and coho, some of which are listed as threatened or endangered under the ESA.

The FMP includes stock and stock complex-specific management objectives and control rules that annual fishery management measures are designed to meet, in order to ensure fisheries do not have unsustainable impacts on any stocks or stock complexes, and to avoid jeopardizing the continued existence of ESA listed stocks. The regulations use tools including management boundaries, seasons, quotas, minimum harvest lengths, fishing gear restrictions, and recreational daily bag limits (Pacific Fishery Management Council 2016) to ensure fisheries do not exceed any of the management objectives or limits derived from the control rules. In order to avoid exceeding a limit for any stock or stock complex, PFMC salmon fisheries are managed under a "weak stock" approach, in which the fisheries catch less than the allowable harvest levels of healthier stocks in order to keep catch within limits for less healthy or abundant stocks. Additionally, under Salmon FMP Amendment 19, the PFMC has taken steps to also protect prey sources essential to salmon by prohibiting the development of future commercial fisheries targeting essential salmon prey species (Pacific Fishery Management Council 2016).

The states manage non-tribal ocean fisheries within three miles of the coast, as well as inland marine waters (Puget Sound) and freshwater. For fisheries in coastal waters, the states typically mirror federal regulations. Indian tribes have fishing rights off the coast of Washington, in Puget Sound, and in freshwater up and down the coast. The tribes manage fisheries involving their members in geographic areas where their fishing rights apply. There is close coordination between state, tribal, and federal fishery management to ensure that the combined impacts of fisheries off the west coast states, and in inland waters, do not result in unsustainable impacts on stocks and are sufficiently protective of ESA listed stocks.

Federally managed ocean salmon fisheries targeting Chinook salmon use troll or hook-and-line gear, but other gear types (e.g., gill nets, purse seines, dip nets, etc.) are also used in other commercial and tribal freshwater salmon fisheries in the Columbia and Klamath Rivers, Puget Sound, Grays Harbor, Willapa Bay, and other river systems. The PFMC includes the following as components of the salmon fishery (Pacific Fishery Management Council 2019 and at https://www.pcouncil.org/learn-more-about-salmon/ accessed 25 September 2020):

- Recreational:
  - Ocean
  - Inland marine (Puget Sound, Strait of Juan de Fuca, coastal bays)
  - Freshwater (including Columbia River Buoy 10)
- Commercial:
  - Treaty Indian and non-Indian ocean troll
  - Puget Sound seine and gillnet
  - Washington coastal bays gillnet
  - Lower Columbia non-Indian gillnet
  - Mid-Columbia treaty Indian gillnet
- Tribal Ceremonial and Subsistence (gillnet, dip net and hook and line):
  - Puget Sound
  - Washington coastal rivers and bays
  - Columbia River and its tributaries
  - Klamath River and Trinity Rivers

Current management regimes help to promote the conservation of salmon by limiting harvest through FMPs and implementing regulations, reducing impacts to Essential Fish Habitat (EFH) through the EFH consultation process, and consulting on federal activities that may jeopardize the continued existence of listed salmon species through ESA section 7 consultation process. However, while regulations of annual harvest are designed to meet MSA standards and protect against jeopardizing the continued existence of the species or adverse modification to their critical habitats, management of fishing activities have largely been focused on protecting listed salmonids and ensuring that effects to non-listed salmon are sustainable. Because the fisheries affect the abundance of salmon that may otherwise be available to Southern Residents as prey, NMFS has consulted on those effects under ESA section 7 for both ocean and inland salmon fisheries.

In April 2019, NMFS reinitiated consultation on implementation of the Pacific Coast Salmon FMP to consider impacts of prey removal and potential for interaction with fishing gear and vessels on Southern Resident killer whales. Subsequently, the PFMC formed an ad-hoc Southern Resident Killer Whale Workgroup (Workgroup) to assist the Council and NMFS in considering and reassessing the effects of coastal salmon fisheries on the whales' prey base and develop approaches the Council could consider for limiting fishery impacts on prey availability. In June 2020, the Workgroup finalized their Risk Assessment (Pacific Fishery Management Council 2020a). As part of their assessment of effects of coastal salmon fisheries, the Workgroup estimated adult Chinook abundance in seasonal time steps and specific areas (North of Cape Falcon, Southwest West Coast Vancouver Island, Salish Sea, Oregon coast (Cape Falcon, OR to Horse Mountain, CA), and the California coast, south of Horse Mountain) using Fishery Regulation Assessment Model (FRAM) and a state-space model of Chinook Salmon (Shelton *et al.* 2018). Reductions in adult abundance by the PFMC ocean salmon fisheries were estimated for each seasonal time-step and spatial area from 1992-2016. Reductions in Chinook abundance due to the PFMC ocean salmon fishery were estimated to range from 0.9%-30.1% between 1992-2016 in the U.S. Economic Exclusion Zone, but have declined over time, with a maximum reduction of 12.2% in the last 10 years. During the entire time series (1992-2016), yearly area specific Chinook reductions were estimated to be 1.2-7.7% North of Cape Falcon, 0.7-26.3% of the Oregon coast, 0.4-60% off the coast of California, and 0.5-3.4% in the non-coastal area including Salish sea and off the coast of Southwest, West coast of Vancouver island.

In April 2020, NMFS completed a Biological Opinion on the 2020 fishery management measures developed under the PFMC Salmon FMP for Southern Resident killer whales and their current and proposed critical habitat (NMFS 2020a). NMFS evaluated the direct and indirect effects of the proposed FMP on the Southern Resident killer whale DPS, incorporating the analyses of the PFMC Workgroup's Risk Assessment. We view this one year biological opinion as part of the first step in assessing the fisheries using a long-term adaptive approach. In September 2020, the PFMC Workgroup provided a draft of potential alternative management approaches to the Council for its consideration. The Council adopted a range of alternatives for further analysis and consideration at the September meeting based on the Workgroup's recommendations, and adopted a final preferred alternative in November 2020 to forward to NMFS for our consideration. The NMFS West Coast Region's Protected Resources Division used the final decision of the Council in November as part of the proposed action analyzed in a new biological opinion. That opinion consulted on the operation of the west coast salmon fisheries in the EEZ conducted under the Council's Salmon FMP as amended by proposed Amendment 21 (that reflect the final preferred alternative) (NMFS 2021b). The proposed Amendment, if approved by NMFS, would establish a threshold representing a low pre-fishing Chinook salmon abundance in the North of Falcon area (management area off of Washington coast and northern Oregon, including the EEZ and state ocean waters), below which the Council and states would implement specific management measures (NMFS 2021b, *see also* 86 FR 29544; June 2, 2021).

A.1.b. Pacific groundfish fisheries

Incidental catch in the Pacific groundfish fishery may also reduce prey. Harvest of Pacific groundfish is managed under the Pacific Coast Groundfish FMP. This diverse management plan includes over 90 different fish species and multiple gear types along the coasts of Washington, Oregon, and California. The groundfish fishery includes commercial, tribal, and recreational components. Most groundfish are harvested with trawls, but they can also be caught with troll, longline, hook and line, pots, gillnets, and other gear (Pacific Fishery Management Council 2017b).

A major emphasis of the fishery management framework is keeping catch within annual catch limits (ACLs) that are based on the most current stock assessment data and include a buffer above the overfishing limit (OFL) to account for scientific uncertainty in determining the OFL. ACLs are set through a biennial harvest specification process. Specifications are adopted together with management measures designed to ensure catch does not exceed the ACLs, and to achieve other goals and objectives that pertain to socioeconomics and equitable utilization of the resource. During the biennium, management measures designated as routine may be adjusted through the in season management process to address new information about the fishery.

According to observer and catch monitor data, most salmon caught in the groundfish fishery are Chinook salmon. Table 3 shows Chinook bycatch by groundfish fishery sector for 2002 to 2015. During this period, Chinook bycatch across fisheries averaged over 9,200 fish per year. The highest annual bycatch of Chinook occurred in 2003, when the groundfish fisheries took nearly 23,000 Chinook (NMFS 2017b). Reasonable and prudent measures put in place to minimize the impact of the amount or extent of incidental take by the groundfish fishery include caps on bycatch in the whiting and non-whiting sectors.

Table 3. Chinook salmon mortality (number of fish) by sector in Pacific Coast Groundfish Fisheries, 2002-2015 (NMFS 2017b).

Year	At-sea whiting	Shore-based whiting	Tribal whiting[a]	Bottom trawl	Mid-water non-whiting	Non-trawl gear[b]
2002	1,663	1,062	1,004	14,501	-	22
2003	2,617	425	3,413	16,433	-	72
2004	803	4,206	3,743	1,758	-	43

Year	At-sea whiting	Shore-based whiting	Tribal whiting[a]	Bottom trawl	Mid-water non-whiting	Non-trawl gear[b]
2005	3,958	4,018	3,980	808	-	32
2006	1,192	839	1,931	67	-	20
2007	1,317	2,462	2,400	194	-	0
2008	718	1,962	696	449	-	0
2009	318	279	2,145	304	-	22
2010	714	2,997	678	282	-	16
2011	3,989	3,722	828	175	-	8
2012	4,209	2,359	17	304	12	63
2013	3,739	1,263	1,014	323	71	124
2014	6,695	6,898	45	984	661	36
2015	1,806	2,002	3	996	482	40

a Includes only the Pacific whiting fishery. Tribal non-whiting fishery values not available.
b Includes bycatch by vessels fishing under exempted fishing permits not already included in a sector count. Added Chinook bycatch by year under exempted fishing permits was 22 in 2002, 51 in 2003, 3 in 2004, and 1 in 2014.

A.1.c. Coastal pelagic fisheries

Incidental catch in the PFMC's Coastal Pelagic Species (CPS) fishery may also reduce prey. The PFMC's CPS FMP specifies a management framework for northern anchovy, market squid, Pacific sardine, Pacific mackerel, and jack mackerel. Generally, these species are targeted with "round-haul" gear including purse seines, drum seines, lampara nets, and dip nets (Pacific Fishery Management Council 2021). These fisheries have the potential to impact Pacific salmon through incidental capture or by removing prey biomass from the ecological system (Pacific Fishery Management Council 2014c, 2020b).

The CPS fishery primarily operates off southern and central California, but there is a large sardine fishery off Oregon and Washington. Fishing mainly takes place near six ports in three main fishing areas: southern California (San Pedro/Terminal Island and Ventura), central California (Monterey and Moss Landing), and Pacific Northwest/Columbia River area (Astoria, Oregon and Westport, Washington). Almost no fishing occurs between San Francisco and Astoria (NMFS 2018b).

The CPS FMP establishes an environmentally based harvest guideline for Pacific sardine accounting for the effect of ocean conditions on stock productivity. Pacific sardine is an important source of forage for a large number of birds, marine mammals, and fish not managed by the FMP. Within the coast-wide allocation, annual harvest guidelines are developed by the PFMC based on recommendations of the CPS Advisory Subpanel and Management Team. The directed Pacific sardine fishery has been closed since July 1, 2015 because of low biomass, but small-scale directed fishing can still take place.

In the Pacific sardine fishery, fishing generally occurs year-round off the coast of central and southern California, but fishing off the coasts of Oregon and Washington generally does not begin until the middle of June due to weather constraints in the Pacific Northwest and state imposed fishing season in Washington State (April 1-December 31).

The Pacific sardine fishery has management measures in place to mitigate interactions with protected species. For example, all species of trout and salmon are prohibited species within all CPS fisheries, and must be returned to the water as quickly as possible with minimal injury. The State of Washington does not allow fishing in state waters (i.e., shoreline to 3 nm) in order to minimize bycatch and conserve forage fish. Additionally, a condition of the Washington's state sardine permit is that no salmon may be landed on the boat's deck, but must be released or dip netted directly from the net before the completion of each set. The state of Oregon allows fishing in state waters and requires fishermen to maintain logbooks. Fishermen are also required to use a grate over the intake of the hold to sort out larger species of fish in order to minimize the take of incidentally caught species. Sardine fishermen are also encouraged to remove salmon from their nets using a dip-net to prevent injury or death to the salmon. In California, fishing occurs near the coast, although outside of 3 nm of shore per state law in many areas.

Estimates of total salmon bycatch are provided by Oregon and Washington on an annual basis. The state of Washington uses information derived from their observer program, while Oregon uses the information provided in the logbook reports from fishermen (Table 4). There is a clear discrepancy between the salmon bycatch rates of fishermen from each state, although they essentially fish in the same area. A comparison of logbook and observer data from 2000 to 2004 indicated that logbook data in the Washington sardine fishery generally under-reported bycatch by 20-80% (Culver & Henry 2006). This is likely the case as well in Oregon. As such, the logbook estimates from Oregon fishermen should be viewed with caution, and may not differ significantly from the observer generated estimates based on sardine tonnage caught when corrected for bias (NMFS 2010).

Table 4. Salmonid bycatch in Pacific sardine fisheries in Oregon and Washington, 2000-2016/17[4,5], in numbers of live and dead fish by species (Pacific Fishery Management Council 2014b, Pacific Fishery Management Council 2017a).

	Oregon[1]										Washington[2]									
	Chinook		Coho		Pink	Unidentified		Total		Grand Total	Chinook		Coho		Pink	Unidentified		Total		Grand Total
	Live	Dead	Live	Dead	Live	Live	Dead	Live	Dead		Live	Dead	Live	Dead	Live	Live	Dead	Live	Dead	
2014/15								17	7	24	44	146	27	166				71	312	383
2014[3]								0	0	0	6	21	4	24				10	45	55
2013								117	81	198	207	683	125	779				332	1462	1794
2012								61	64	125	244	806	148	919				392	1725	2117
2011								35	37	72	56	186	34	212				90	398	488
2010								110	76	186	87	288	53	328				140	616	756
2009								126	115	241	56	186	34	212				90	398	488
2008								123	75	198	45	149	27	170				72	319	391
2007								349	170	519	33	108	20	124				53	232	285
2006								164	93	257	31	101	19	116				50	217	267
2005								411	176	587	47	156	29	178				76	334	410

	Oregon[1]										Washington[2]									
	Chinook		Coho		Pink	Unidentified		Total		Grand Total	Chinook		Coho		Pink	Unidentified		Total		Grand Total
	Live	Dead	Live	Dead	Live	Live	Dead	Live	Dead		Live	Dead	Live	Dead	Live	Live	Dead	Live	Dead	
2004								518	305	823	35	225	19	105	0	39	0	93	330	423
2003								315	185	500	92	262	81	231	0	173	0	346	493	839
2002								199	81	280	150	356	61	765	0	200	0	411	1211	1532
2001	45	45	201	134	22	45	0	313	179	492	449	170	571	504	0	80	0	1100	674	1774
2000	43	72	159	43	0	303	43	505	158	663	38	3	276	116	0	7	0	321	119	440

1 Oregon salmon bycatch data for 2000-2001 are expanded from a bycatch rate of salmon/trip based on vessel observation program. Oregon salmon bycatch data for 2002-2015 are from logbooks. No sardine fishery landings were made in Oregon during January 1-June 30, 2014.

2 Washington totals calculated from observed 2000-2004 observed bycatch rates.

3 January 1, 2014 – June 30, 2014.

4 The 2015/16 directed sardine fishery was closed.

5 The 2016/17 directed sardine fishery was closed.

In July, 2004, the NMFS Southwest Region (prior to merging with the Northwest Region to form the West Coast Region) initiated a pilot observer program on commercial vessels operating out of California ports targeting CPS. Between July 2004 and September, 2005, there were 27 observed trips on vessels targeting sardine, totaling 56 observed sets. A federal observer program operated from January 2006 to January 2008 and a total of 199 trips (426 sets) were observed. No marine mammals, sea turtles, salmonids, or seabirds were observed as bycatch. In California, longer-term information on bycatch comes from dockside monitors employed by the California Department of Fish and Game, who have been regularly monitoring the sardine landings in the Monterey Bay area and southern California since the mid-1980s. The State of California conducts portside catch sampling at San Pedro, California and Monterey, California. The sardine landings have been sampled approximately 12 days per month for the past 20 years, and thus far, one salmon has been observed (NMFS 2010).

All these directed and incidental fishing activities described above remove prey and potentially have impacts on the prey essential feature.

A.2. Salmon hatcheries

Salmon hatcheries contribute to the abundance of salmon available to Southern Residents within newly designated coastal critical habitat. However, there are several concerns with how artificial propagation of salmonids may impact natural salmon populations or the habitats essential to their survival, and therefore hatchery activity has the potential to affect the prey essential feature.

Hatchery production is a significant component of the salmon prey base returning to watersheds within the range of Southern Resident killer whales (Barnett-Johnson *et al.* 2007; NMFS 2008a). The release of hatchery fish has not been identified as a threat to the survival or persistence of Southern Residents and there is no evidence to suggest the whales prefer wild salmon over hatchery salmon. Increased Chinook abundance, including hatchery fish, benefit this endangered population of whales by enhancing prey availability to Southern Resident killer whales and hatchery fish often contribute significantly to the salmon stocks consumed (Hanson *et al.* 2010). Currently, hatchery fish play a mitigation role of helping sustain Chinook salmon numbers while other, longer term, recovery actions for natural fish are underway. Although hatchery production has contributed some offset of the historical declines in the abundance of natural-origin salmon within the range of the whales, hatcheries also pose risks to natural-origin salmon populations (Nickelson *et al.* 1986; Ford 2002; Levin and Williams 2002; Naish *et al*. 2007). Healthy natural-origin salmon populations are important to the long-term maintenance of prey populations available to Southern Residents because it is uncertain whether a hatchery dominated mix of stocks is sustainable indefinitely.

Generally, speaking, in the past hatcheries have been used to compensate for factors that limit anadromous salmonid viability (e.g., harvest, human development) by maintaining fishable returns of adult salmon and steelhead. A new role for hatcheries emerged during the 1980s and 1990s as a tool to conserve the genetic resources of depressed natural populations and to reduce short-term extinction risk (e.g., Snake River sockeye salmon). Hatchery programs also can be used to help improve viability by supplementing natural population abundance and expanding spatial distribution. However, the long-term benefits and risks of hatchery supplementation remain untested (Christie *et al.* 2014). Therefore, fixing the factors limiting the viability of natural-origin populations is essential for long-term viability.

NMFS evaluates hatchery programs to assess potential effects on listed salmonids under section 7 of the ESA and may include mitigation or conservation measures to limit the risk of negative impacts. For example in the recent 2016 Biological Opinion for Mitchell Act funded Columbia River Basin hatchery operations (NMFS 2017a), NMFS outlined several conservation recommendations that included:

- Halting the use of hatchery broodstock that originate outside the Columbia River to reduce genetic risk to native fish stocks;
- Reducing hatchery production in some places;
- Increasing hatchery production where stray hatchery fish are not a threat to recovery of protected salmon and steelhead; and
- Conducting additional research and monitoring to better track and understand the effects of hatchery fish on wild salmon and steelhead populations.

Special management considerations for hatchery operations that are specific to the prey feature of Southern Resident killer whale critical habitat might include adjusting hatchery production to fill critical gaps of the prey base for the whales in specific seasons or locations.

A.3. Offshore aquaculture/mariculture

Aquaculture and mariculture (cultivation of marine organisms) may impact critical habitat features by reducing water quality through site construction, waste disposal, release of pesticides or antibiotics, introduction of pathogens or invasive species to the marine environment, or blocking access to foraging areas (passage). At this time, aquaculture facilities are limited to inshore and estuary environments adjacent to the critical habitat expansion, with offshore activities limited to an area south of Point Conception, California. In California, finfish aquaculture is also not allowed in state waters.

Most U.S. West Coast aquaculture occurs in inland waters, bays, and estuaries. However, proposals for offshore facilities may increase in the future. If proposed areas are located within Southern Resident killer whales critical habitat, special management may be required to mitigate impacts to water quality or passage. For example, Price *et al.* (2017) identify exclusion from habitat and modification of habitat use as potential impacts to marine mammals from offshore mussel aquaculture facilities.

Permitting for offshore aquaculture in federal waters is managed by the U.S. Army Corps of Engineers (USACE) through the issuance of Rivers and Harbors Act section 10 (33 U. S.C. 403) permits, which allow for any construction in or alteration of navigable U. S. territorial waters. If pollutant discharge is expected, a National Pollutant Discharge Elimination System (NPDES) permit may also be required (Price *et al.* 2017). In addition, for certain projects, permits by the U.S. Coast Guard (USCG) for bridges and private aids to navigation (to ensure safe navigation) may be needed (Laschever et al. 2020).

Given the preferred passage areas used by Southern Resident killer whales for travel between foraging habitats identified in section IV, any future large-scale offshore aquaculture facilities proposed in those areas projects would be considered under the current management framework to minimize any impact on the whales' and safe passage.

A.4. Alternative energy development

On the U.S. West Coast, several offshore alternative energy projects have been proposed including wave and hydrokinetic arrays. These projects have the potential to limit passage of Southern Resident killer whales and potentially have impacts on prey and water quality.

Marine hydrokinetic energy refers to electrical energy that comes from "(1) waves, tides, and currents in oceans, estuaries, and tidal areas; (2) free flowing water in rivers, lakes, and streams; (3) free flowing water in man-made channels; and (4) differentials in ocean temperatures (ocean thermal energy conversion)" (section 632 of the Energy Independence and Security Act of 2007, Pub. L. 110-140, signed December 19, 2007). Wave and tidal energy converters have the potential to affect the quality and quantity of Southern Resident killer whales' preferred prey, water quality, and Southern Resident killer whale safe passage to foraging sites. Elements of these projects may impact habitats essential to salmon survival (Pacific Fishery Management Council 2014a), and therefore the quality and quantity of available prey for Southern Resident killer whales, through: (1) alteration of current and wave strengths and directions; (2) concentration of displaced fishing gear; (3) presence of rotor blades or other moving parts; (4) sound and vibration in water column during construction and operation; (5) generation of electromagnetic fields by electrical equipment and transmission lines; (6) release into water column of toxic chemicals from paints, lubricants, antifouling coatings, as well as spills of petroleum products from service vessels; and (7) platforms providing shelter or resting sites for other salmon predators such as California sea lions which may result in concentrated predation in those areas (Pacific Fishery Management Council 2014a).

Non-federal hydrokinetic (i.e., wave and tidal) energy projects are licensed through the Federal Energy Regulatory Commission. In federal waters, alternative energy projects, including wind and solar, are permitted through the Bureau of Ocean Energy Management (BOEM). Proposals for alternative energy sites in the areas within the newly designated critical habitat designation have been limited, and several are still in the theoretical stages. Biological opinions conducted on these projects have resulted in conservation measures mitigating direct impacts to Southern Resident killer whales. Additionally, the PFMC lists several potential conservation measures for alternative energy development to help reduce negative impacts of these activities on salmon and salmon EFH (Pacific Fishery Management Council 2014a).

A.5. Oil spills and response

Exposure to oil from spills has been implicated in long-term killer whale mortalities and lack of recovery in some Alaskan populations (Matkin *et al.* 2008). Oil spills as well as response activities may affect water quality and the prey of Southern Resident killer whales. The severity of oil spill impacts on the marine environment depends on the volume of the spill, duration, and the type of petroleum product, in combination with the physical factors at the location of the spill such as wind, wave, and current conditions. Minimization of impacts from oil spills depends on the ability to respond to the spill and the effectiveness of methods used to remove or disperse the oil. The emergency nature of these events requires that general response activities are planned in advance and that protocols are adjusted to ensure that methods selected to disperse or remove oil reduce, to the extent possible, additional destruction to the site of the spill or destruction to nearby habitats.

Oil spill risk exists throughout the Southern Resident killer whales' coastal range. From 2002-2016, the highest-volume crude oil spill occurred in 2008 off the California coast, releasing 463,848 gallons (Stephens 2017). In 2015 and 2016, crude oil spilled into the marine environment off the California coast totaled 141,680 gallons and 44,755, respectively; no crude oil spills were reported off the coasts of Oregon or Washington in these years (Stephens 2015, Stephens 2017). Non-crude oil spills into the marine environment also occurred off California, Oregon, and Washington in 2015 and 2016 (Stephens 2015, Stephens 2017). Many crude and non-crude oil spills also occur in fresh water, or on land, which may also have impacts for watersheds and habitats important to salmon.

Throughout the nation the response and recovery efforts associated with oil spill events are planned in advance to provide protection to environmental and economic interests; the National Oil and Hazardous Substances Pollution Contingency Plan provides the organization, structure, and procedures for this type of planning (40 CFR Part 300). The current Northwest Area Contingency Plan includes plans to deter killer whales from oil spills sites (USCG *et al.* 2018) as well as special management considerations to protect Southern Resident killer whales essential features in the case of an oil spill. Plans to protect Southern Resident killer whale critical habitat include contacting appropriate NMFS staff during a spill event to provide expertise, identifying the essential features present in the area of the spill, and identifying the appropriate response to protect those features during the recovery efforts. While the use of oil spill dispersants may affect Southern Resident killer whales if they are directly sprayed on them (via irritation of the eyes or other membranes), they are an important tool for minimizing the amount of oil on the surface of the water and that may reach sensitive habitats such as marine mammal haul-out sites, and the shorelines and wetlands that support spawning and rearing of different types of salmonids.

Depending upon location (Alaska, California, Oregon, or Washington), oil spill response plans require 300-600 foot (91.4-182.9 m) buffers between marine mammals and on-water response activities as well as vertical separation of at least 500 meter (1,630.4 ft) for aircraft to avoid ship strikes or unintentional harassment. Response personnel are assigned as wildlife spotters in both air and sea operations to aid in maintaining these buffers. Application of dispersants onto marine mammals is not allowed. Ships are usually required to reduce speeds to between 10-13 knots when marine mammals are observed in the area.

The use of oil spill dispersants may increase the short term impacts to portions of ecological systems such as marine copepods or larval fishes directly under the area sprayed compared to the impacts of the naturally dispersed oil fraction (National Research Council 2005). However research shows minimal or insignificant effects to adult fish, such as the salmonids that Southern Resident killer whales prey upon, when compared with the effects from undispersed oil (Maynard & Weber 1981, Weber *et al.* 1981, Brannon *et al.* 1986, Nakatani & Nevissi 1991, Wolfe *et al.* 1998, Wolfe *et al.* 1999, Wolfe *et al.* 2001, National Research Council 2005, Lin *et al.* 2009, Tjeerdema *et al.* 2010, BenKinney *et al.* 2011, Ylitalo *et al.* 2012, Bejarano *et al.*

2014). Marine zooplankton populations are expected to bounce back quickly under typical oil spill and/or dispersant use scenarios (National Research Council 2005, Varela *et al.* 2006, Symons & Arnott 2013).

Special management considerations (including those described above) may be needed to address impacts of oil spills and oil spill response by federal agencies on water quality and prey features within Southern Resident critical habitat.

A.6. Military activities

Within the coastal areas we considered for critical habitat designation, naval military training and testing activities occur in the offshore Pacific Northwest Ocean Surface/Subsurface Operating Area (OPAREA), Warning Area 237 (W-237), and the Olympic A and B Military Operation Areas (MOA), which are all considered at-sea components of the Northwest Training Range Complex (NWTRC), as well as in the Quinault Range Site (QRS), which is a component of the Keyport Range Complex (Figure 24). The Navy refers to all the at-sea areas used for training and testing as the Northwest Training and Testing (NWTT) study area. Military activities in these areas may affect the prey essential feature through direct impacts to fish. Sonar and active acoustic sources from military activities might also create a barrier that could restrict the whales' passage through or within an area necessary for migration, resting, or foraging (affecting the passage feature of critical habitat).

The NWTRC offshore OPAREA extends westward from the Strait of Juan de Fuca to 130° W. longitude (approximately 250 nautical miles [463 km]), and southerly parallel to the coasts of Washington, Oregon, and northern California. The eastern boundary of the offshore OPAREA is 12 nm (22.2 km) from shore for most of the range, including southern Washington, Oregon, and Northern California. The offshore OPAREA includes the ocean all the way to the coastline only along the Washington coast beneath the airspace of W-237 and the Olympic MOA and the Washington coastline north of the Olympic MOA. The QRS underlies W-237A within the NWTRC offshore OPAREA, and also includes a surf zone area and one mile of shoreline at Pacific Beach, Washington (Figure 24) (U.S. Navy 2015).

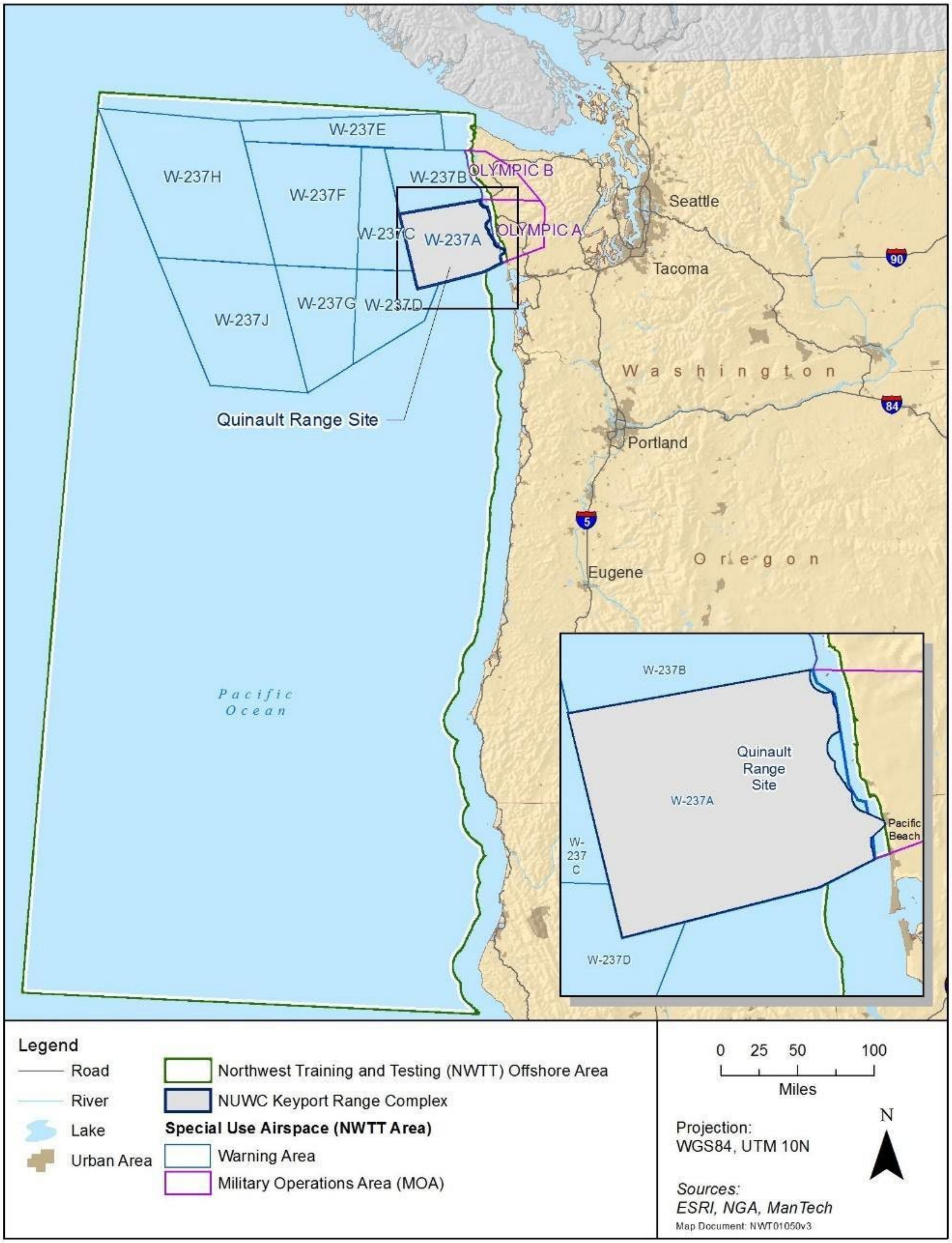

Figure 24. Area map showing the Offshore Area of the Navy's Northwest Training and Testing study area (U.S. Navy 2015).

Satellite tagging research showed Southern Resident killer whales use areas within the eastern portion of the offshore OPAREA. The tagged whales used only about 9.7% of area W-237 and spent about 15% of their time there (though the amount varies between pods) (Hanson *et al.* 2017, and see the ESA Section 4(b)(2) Report Appendix A, NMFS 2021a).

Training activities within offshore naval sites may affect the prey essential feature. The NWTRC offshore OPAREA has long been used for training activities by the Navy's Pacific Fleet, in addition to research, development, testing, and evaluation of ships, aircrafts, weapons, and their operating systems. Some activities that create high intensity underwater sound (such as sonar devices) or pressure waves (such as some explosives), may impact Southern Resident killer whales prey, but there are many differences between sonar and explosions with respect to their anticipated impacts on prey species. For example, most marine fishes, including killer whale prey, cannot detect mid- or high-frequency sonar. This means only a limited amount of low-frequency sonar could impact prey species in these areas, but those impacts would likely be limited to short-term behavioral responses that would not reduce overall prey availability. Unlike other acoustic stressors, explosives release energy at a high rate, producing a shock wave that can be injurious and even deadly. The effects of explosions on fishes have been studied and reviewed by numerous authors (O'Keeffe 1984, Keevin & Hempen 1997, Popper *et al.* 2014). Fishes could be exposed to a range of impacts depending on the explosive source and context of the exposure. In addition to acoustic impacts including temporary or permanent hearing loss, auditory masking, physiological stress, or changes in behavior, potential impacts from an explosive exposure on fish can include non-lethal injury and mortality.

Southern Resident killer whales may be exposed to sonar and other active acoustic sources associated with U.S. Navy testing and training activities while they reside in the NWTT area, possibly affecting Southern Resident use of the area for passage. The Department of Defense (DOD) already consults with NMFS to ensure its activities are not likely to jeopardize listed species; in these consultations, the impacts to the species are assessed. For example, for sonar-related activities, the consultation includes the potential for these activities to result in behavioral, acoustic, and physiological effects on listed species such as Southern Resident killer whales. As relevant to this evaluation, however, behavioral disturbance could include avoidance of an area or deviation in swimming path that could affect the passage feature. To ensure that their activities are not likely to jeopardize Southern Resident killer whales and other listed species, the DOD engages in many best management practices to minimize the impacts to the marine environment (e.g., posting lookouts, establishing mitigation zones, powering down or shutting down sonar when cetaceans are detected within a certain range), and conducts monitoring and research to provide better information about potential impacts to protected species and their habitat. Many of these types of military activities were previously consulted on for a five-year period, recently changed to a seven-year period (via an amendment to MMPA section 101(a)(5)(A) in section 316 of the National Defense Authorization Act for Fiscal Year 2019), and an annual review of monitoring reports and activities is conducted. In addition, these activities are also reviewed under the MMPA (16 U.S.C. 1361 et seq), which allows NMFS to authorize the incidental take of marine mammals during the Navy's specified activities, determine permissible methods of taking, determine other means of effecting the least practicable adverse impact on marine mammals species or stocks and their habitat, and determine requirements pertaining to the monitoring and reporting of the incidental take. These MMPA

Letters of Authorization are also issued for a now seven-year period. The current Letter of Authorization allows for NWTT activities to take 51 Southern Residents by Level B harassment annually from November 2020 through November 2027 (85 FR 72312; November 12, 2020).

In order to reduce impacts to marine mammals, including behavioral disturbance that could affect passage, and endangered fish, including prey for the whales, from naval testing and training activities, the U.S. Navy employs an observer program, as well as several other seasonal and procedural mitigation measures. For example, at the Hood Canal EOD Range, during August, September, and October (the adult migration period for Hood Canal summer-run chum and Puget Sound Chinook), the Navy will avoid using explosives in bin E3 (> 0.5–2.5 pounds net explosive weight) and will instead use explosives in bin E0 (< 0.1 pounds net explosive weight) to the maximum extent practical unless necessitated by mission requirements (NMFS 2020b, Navy 2020a,b). Additionally, during February, March, and April (the juvenile migration period for Hood Canal summer-run chum) at the Hood Canal EOD Range, the Navy will not use explosives in bin E3 (> 0.5–2.5 pounds net explosive weight), and will instead use explosives in bin E0 (< 0.1 pounds net explosive weight) (NMFS 2020b, Navy 2020a,b). Finally, at the Crescent Harbor EOD Range, the Navy will conduct explosive activities at least 1,000 m from the closest point of land.

A.7. Vessel traffic

There is substantial vessel traffic along the U.S. West Coast, particularly into and out of major ports (Figure 27 in Appendix B). Ship traffic occurs within the Southern Residents' coastal range, although large commercial ships and ships containing hazardous material generally remain farther offshore than the 200-meter (656.2 ft) isobath. Individual vessels in close proximity to individual whales can elicit a behavioral response; this is assessed as a potential effect on individuals (not critical habitat) in ESA section 7 consultations. However, the long-term physical presence of high vessel traffic (e.g., in shipping lanes or heavily trafficked whale-watching areas) may, in some cases, present an obstacle to free passage by the whales or potentially cause whales to expend additional energy avoiding vessels, impacting resting and foraging behavior. Chronic sound from high vessel traffic may also reduce the availability of the whales' prey in a particular foraging area by reducing the effective echolocation space for the whales to forage. The chronic sound might also create a barrier that restricts the whales' passage through or within an area necessary for migration, resting, or foraging.

Management of vessels is dependent on the vessel class and particular marine safety or environmental issues. Vessel issues that may impact Southern Resident killer whale critical habitat or affect essential habitat features are: vessel traffic operations and shipping lanes (related to safety), vessel speeds related to shipping or directed whale watching and environmental threats from spills or debris that may result from collisions or grounded vessels. Typically the International Maritime Organization (IMO), Department of Transportation, and the USCG are the organizations that determine shipping vessel traffic separation schemes (TSS) and vessel safety restrictions for shipping and container vessels transiting regional and international waters. Other vessels are registered with state environmental agencies and those of five net tons or greater may be federally documented with the USCG. Vessels engaged in commercial or charter fishing must also obtain fishing permits from NMFS.

To reduce impacts of vessels on Southern Residents in their inland habitat, NMFS announced new regulations to protect killer whales in April 2011 (76 FR 20870; April 14, 2011). The regulations prohibit vessels from approaching any killer whale closer than 200 yards (182.9 m) and prohibit vessels from intercepting or parking in the path of the whales within 400 yards (365.8 m) when in inland waters of Washington. However, because commercial and recreational whale watching primarily occurs in inland waters of Washington, the restrictions are not applicable in the outer coastal areas that make up the newly designated critical habitat areas. The Be Whale Wise guidelines (www.bewhalewise.org) advise all vessels on responsible viewing practices to reduce potential impacts to the whales movements and behaviors, such as foraging, and apply all along the West Coast.

Other vessel management schemes include voluntary areas to be avoided implemented by the Olympic Coast National Marine Sanctuary (OCNMS) with the intention of protecting marine habitats from potential impacts that might result from vessel collisions or groundings.

A.8. Dredging and dredge material disposal

The periodic dredging of harbors is a necessary component of keeping the harbor channels clear and allowing safe access for all types of vessels (MBNMS 2019). Environmental concerns about dredging include the dispersal of previously settled contaminants (such as DDT, PCBs, or polycyclic aromatic hydrocarbons) into the water column, or at the disposal site, and degradation of habitat due to sedimentation. As such, there may be impacts on the water quality feature of critical habitat and to the prey essential feature (i.e, impacts to prey quality through exposure. Prey abundance could also be impacted through salmon habitat impacts and vessels and sound associated with dredging, disposal or other associated construction could impact the passage feature.

Working with states and local municipalities, the USACE may permit underwater dredging activities within navigable waterways and these may be associated with other in-water construction activities (e.g., pier and dock construction) or civil works projects related to infrastructure, flood control, or navigation. During these construction and dredging activities, the project must make efforts to minimize any environmental impacts, especially those that may impact endangered or threatened species, or their critical habitats. In the past, NMFS conservation recommendations to help reduce these impacts have included, but are not limited to:

- Confining construction impacts to the minimum area necessary to achieve project goals;
- Ceasing construction/dredging operations under high flow conditions that may result in inundation of the project area, except for efforts to avoid or minimize resource damage; and
- Implementing a pollution and erosion control plan to prevent pollution related to construction actions (NMFS 2014a).

Under the Marine Protection, Research, and Sanctuaries Act (MPRSA), the USACE is also authorized to permit the dumping of the dredged material in offshore ocean waters. Under MPRSA section 102, the EPA is responsible for designating and monitoring sites for the ocean dumping of all materials, including dredged material. The EPA's ocean dumping regulations provide the criteria and procedures for the designation and management of these sites (EPA 2018). Materials disposed of offshore must also comply with Clean Water Act requirements. Management of ocean disposal sites ensures that disposal activities will not unreasonably degrade or endanger human health, welfare, the marine environment or economic potentialities. Management of the ocean disposal sites involves:

- Developing a site management and monitoring plan;
- Regulating the times, quantity and physical/chemical characteristics of disposed material;
- Establishing disposal controls, conditions and requirements to avoid and minimize potential impacts to the marine environment; and
- Monitoring the site and surrounding environment to verify that unanticipated or significant adverse effects are not occurring from past or continued use of the ocean disposal site and that terms of the MPRSA permit are met (EPA 2018).

Additionally, if disposed of within National Marine Sanctuary boundaries, the disposal is further subject to sanctuary consultation and authorization.

A.9. Oil and gas exploration and production

Oil and gas exploration within the critical habitat areas would be cause for concern for reasons associated with the water quality feature (e.g., risk of spills, lubricant or chemical discharge from drilling platforms). Also, these activities have the potential to affect prey and whale passage through destruction of benthic habitat, noise associated with exploration or drilling operations, and vessel traffic that may result from these operations.

There is presently no oil or gas production activity within the newly designated critical habitat areas, and no new lease sales off the coasts of Washington, Oregon, or California have been approved by BOEM through 2022. However, if policies change in the future, procedures such as ESA section 7 consultations on BOEM actions will be useful in protecting physical and biological features of critical habitat, including listed salmon prey.

A.10. Mineral mining (including sand and gravel mining)

The impacts of mineral mining on Southern Resident killer whale critical habitat features are dependent on the type of mining occurring and the minerals being extracted, but in general may affect critical habitat water quality and prey feature. Mineral mining may release chemicals into the marine or aquatic environment or increase turbidity within the water column.

Sand and gravel deposits on the Outer Continental Shelf are managed by BOEM. These resources are used in coastal restoration and beach renourishment projects and are typically extracted using hydraulic dredges in waters of 100 m (328.1 ft) or less (California Geological Survey 2005). There are no active requests to lease marine minerals from the OSC off the U.S. West Coast (BOEM 2018b), but there is one site within (near San Francisco) and two areas south of the critical habitat expansion that are being assessed for their potential use as sand resource sites (BOEM 2017).

Procedures such as ESA section 7 consultations on BOEM actions will be useful in protecting physical and biological features of the critical habitat, including listed salmon prey and water quality. Upstream mineral mining is regulated by state and federal regulations, and is subject to the Clean Water Act with respect to the discharges produced.

A.11. Geologic surveys (including seismic surveys)

Geological and geophysical marine surveys provide information used by government, industry, and researchers to better understand the composition of substrate and to evaluate the potential for offshore oil, gas, methane hydrate resources, non-energy/marine mineral resources, and geologic hazards. Seismic surveys are a subset of these geologic and geophysical surveys using high powered air and water gun arrays, sending seismic pulses to create imaging of the substrate. These disturbances might create a barrier that restricts the whales' passage through or within an area necessary for migration, resting, or foraging (affecting the passage feature of critical habitat).

BOEM authorizes these surveys when they are included as a part of an oil and gas lease plan. When conducted as a part of research, or outside the oil and gas exploration leasing system, other agencies, such as the USACE must provide authorization. The National Science Foundation also funds seismic exploration for research purposes. NMFS consults on these activities in order to issue MMPA Letters of Authorization for any incidental takes expected to occur.

Conservation modifications to protect marine mammals, and that may apply to protecting the essential habitat feature of safe and unrestricted passage of Southern Residents, may include measures that take place before and during seismic operations such as:

- Prepare an Environmental Assessment including any known marine mammal presence or behaviors within the expected study area;
- Establish an "exclusion" or safety zone around the seismic airgun source where mitigation would be undertaken to avoid or minimize the impacts of the airguns if marine mammals or sea turtles are observed within it;
- Not operate the multi-beam echosounder, the sub-bottom profiler, or the acoustic Doppler current profiler during transit;
- Conduct seismic operations during daylight hours where possible;
- Use NMFS-approved vessel-based observers to watch for and monitor marine mammal or sea turtle species near the seismic source vessel during airgun operations;
- Deploy hydrophones to detect and monitor marine mammal acoustics prior and during seismic array deployment;
- Record marine mammal or sea turtle is sightings;
- Visually observe the entire extent of the exclusion zone using observers, for at least 30 min prior to starting the airgun (day or night);
- Delay or stop seismic surveys if marine mammals or sea turtles are sighted within the exclusion zone. Immediately cease activities if an unauthorized take, such as an injury or death, is suspected to have occurred; and
- Activate the sound source at the lowest possible source level and increase at a prescribed rate (not to exceed 6 dB per 5 minutes) to allow marine mammals in the vicinity to detect, track, and avoid the sound.

(NMFS 2012b)

A.12. Upstream activities

A number of activities that occur in shallow nearshore waters (less than 20 feet of water depth) or upstream of the Southern Resident killer whale critical habitat expansion may affect the essential features of the whales' critical habitat, particularly the prey and water quality features. Although these activities do not occur within the critical habitat expansion, future section 7 consultations on these projects and activities may require consideration of the potential for adverse modification of the whales' critical habitat. These include activities contributing to point-source water pollution (e.g., agricultural pesticide application, National Pollutant Discharge Elimination System permitting), power plant operations, liquefied natural gas terminals, and desalinization plants. Additionally, some of the activities identified in earlier sections of this report may also occur upstream of critical habitat, such as mineral mining or dredging and other in-water construction in the nearshore habitat.

A.12.a. Activities contributing to point-source water pollution

Activities that contribute to water pollution in areas occupied by Southern Resident killer whales, nearshore waters adjacent to critical habitat, and in upstream freshwater systems that are important to their salmon prey, may also require special management considerations due to effects on the water quality and prey essential features. Impacts of biomagnification from contaminant exposure and ingestion remains one of the biggest threats to Southern Resident killer whales. Pollution may reduce the water quality essential for Southern Resident killer whales' health and successful reproduction, and can reduce the quality of the prey essential feature. Of particular concern are those sources of POPs or their derivatives, due to the health risks posed by bioaccumulation.

Point-source pollution is regulated through National Pollutant Discharge Elimination System permits (sometimes referred to as NPDES permits), with permitting authority granted to state agencies that set standards to meet the requirements of the Clean Water Act. The U.S. Environmental Protection Agency (EPA) maintains oversight. As our understanding of the fate and influence of POPs, chemicals of emerging concern, heavy metals, or other chemicals increases, new management or mitigation methods may be identified to support water quality in marine ecosystems, including areas important to Southern Resident killer whales. The EPA issues NPDES permits for federally owned facilities and all permits on tribal lands in Washington, and the Washington Department of Ecology issues all other permits in the state. The EPA issues all NPDES permits on tribal lands in Oregon, and the Oregon Department of Environmental Quality issues all other permits in the state. The EPA is the permitting authority for tribal lands in California and any discharges into federal ocean waters beyond state boundaries. The State of California, through its State Water Resources Control Board and nine Regional Water Quality Control Boards, issues NPDES permits for discharges on lands (other than tribal lands) within the state.

The most recent pollution and contamination management efforts related to NPDES permits have focused on PBDEs. Southern Resident killer whales have been found to have the highest levels of these chemicals of any other marine organism (Alonso *et al.* 2014). In inland Southern Resident killer whale critical habitat, particularly Puget Sound, one of the primary vectors of contamination of PBDEs is treated wastewater discharge (NMFS 2016b). For permits at federal facilities, such as Joint Base Lewis McChord in Washington, section 7 consultations are conducted under the ESA (NMFS 2012a), and have included mitigation measures such as increased monitoring of contaminants of concern for Southern Residents, such as PBDEs. In conjunction with the EPA, working groups of researchers and state and local managers evaluated data gaps and made mitigation recommendations to reduce the impacts of PBDE contamination to the environment and species in the ecosystem. Recommendations included the removal of PBDEs from wastewater in treatment plants, as well as other research and monitoring components to better understand the impacts these contaminants have on Southern Resident killer whales and their critical habitat (Gockel & Mongillo 2013). Though these recommendations were specific to Puget Sound, this provides an example of special management considerations currently in place to reduce impacts to water quality and thus the whales and their prey. In coastal waters, NMFS recently completed an ESA section 7 consultation on a waste water treatment plant in Los Angeles, California, that required monitoring of PBDE levels in effluent that discharges into Santa Monica Bay (NMFS 2018c).

A.12.b. Power plant operations

Thermoelectric power plants (coal, nuclear, natural gas, oil, and some renewable energy technologies) require the intake of water resources for cooling purposes. Chemically treated or heated water may then be returned to the aquatic environment, causing several environmental concerns that may impact the prey feature of Southern Resident killer whales' critical habitat. Heated effluent may raise temperatures in areas important for varying life stages of salmon, making preferred areas uninhabitable. Additionally younger salmon age classes or salmon prey may become impinged, or stuck, in the water intake systems, causing unidentified ecological impacts by removing these animals from the environment. Effluent from power plants may also have other effects on water quality that affect critical habitat, such as increased turbidity from suspended materials and decreased dissolved oxygen levels (Perkins 1974).

Depending on the type, power plants may be regulated by state and federal government (FERC, Department of Energy, Nuclear Regulatory Commission). The EPA regulates industrial wastewater discharges.

Dam and hydropower operations occurring upstream of coastal Southern Resident killer whale critical habitat may have an impact on the essential habitat features, particularly the prey feature. Hydropower has been identified as a threat impacting salmon recovery. Dams prevent juvenile fish migrating to the ocean and create obstacles for adult fish as they attempt to return to their natal streams to spawn. Dams affect the way water moves down a river by changing the amount and timing of flow, as well as its temperature and chemical characteristics, further compromising the ability of adult salmon to reproduce successfully. Dams transform the upstream habitat from a river into a lake, changing the amount and location of available habitat and significantly altering the salmon's interaction with predators and competitors. Measures to reduce the effects of hydropower and dam operations on salmon and therefore Southern Resident killer whales' essential prey habitat feature can include increasing the number of fish passage facilities and temperature control structures, temperature control, flow modifications, hatchery reforms and upgrades, passage upgrades, irrigation diversion screens, and habitat mitigation projects (NMFS 2008b).

The Federal Power Act grants the Federal Energy Regulatory Commission (FERC) authorization to permit municipal and private developer hydropower projects. If the construction of the project occurs within navigable waters, the project must also receive authorization from the USACE under the Rivers and Harbors Act.

A.12.c. Liquefied natural gas terminals

Liquefied natural gas (LNG) terminals pose the risk of leaks, spills, or pipeline breakage and may affect the water quality feature of critical habitat. In addition, activities associated with the construction, operation, and maintenance of LNG projects may affect water quality, sediment quality, and prey resources for Southern Resident killer whales. For example, dredging operations and in-water and shoreline construction activities associated with the construction and operation of LNG terminals may result in increased erosion and sedimentation, increased turbidity, removal and disturbance of benthic prey species, and the re-suspension of contaminated sediments.

Depending on location and use (e.g., export, supply to interstate pipelines or local distribution companies, storage), an LNG facility may be regulated by several federal agencies and by state utility regulatory agencies. FERC is responsible for authorizing the siting and construction of onshore and near-shore LNG import or export facilities under section 3 of the Natural Gas Act (FERC 2018a). Currently, there are no FERC-approved LNG terminals within the newly designated critical habitat, but the Jordan Cove LNG terminal has been proposed for the port of Coos Bay in Coos County, Oregon (FERC 2018c), which is adjacent to the area being considered for critical habitat. Procedures such as ESA section 7 consultations on FERC actions will be useful in protecting physical and biological features of the environment, including listed salmon prey.

A.12.d. Desalinization plants

Desalinization is the process of removing salt from sea water to make it potable. The process for desalinization may include thermal distillation or reverse osmosis, both of which require seawater intake and the discharge of a highly saline brine effluent back into the marine environment. In addition to concentrated salts from the seawater, the brine may also contain chemicals from the desalination process, heavy metals from the machinery, and concentrated contaminants that were in the seawater (Pacific Fishery Management Council 2014a). Effluent discharged from desalinization plans may affect the water quality feature of critical habitat, increase salinity in the immediate discharge area and into surrounding adjacent waters, and therefore potentially produce ecological changes to the area or have physiological impacts to species present during effluent discharge, which could include the prey essential feature. Desalinization plants are subject to EPA Clean Water Act regulations as well as state laws.

B. Activities That May Require Special Management in Each Area

Below we provide area-specific information, where available, on the activities identified in section VII.A above that may require special management.

All six coastal areas of the newly designated Southern Resident killer whale critical habitat overlap with designated critical habitat for the Southern DPS of green sturgeon (74 FR 52299;

October 9, 2009). The specific features or PCEs essential for the conservation of the green sturgeon DPS in coastal marine areas are similar to those identified for Southern Resident killer whales, including a migratory corridor that allows for safe passage between habitat areas, water quality with acceptably low levels of contaminants, and abundant food resources (some of which may be prey for the killer whales' salmon prey). Because of this overlap in areas and features, management of activities to reduce impacts on green sturgeon critical habitat may also benefit Southern Resident killer whales. Leatherback sea turtle critical habitat (77 FR 4170; January 26, 2012) also overlaps with coastal Areas 1-3 and 5-6 of the newly designated Southern Resident killer whale critical habitat, although the single identified feature for leatherback sea turtles, the occurrence of prey species primarily from the order Semaeostomeae, is not as similar to those identified for killer whales as the green sturgeon features are.

Four national marine sanctuaries overlap with the newly designated Southern Resident killer whale critical habitat. These include the Olympic Coast National Marine Sanctuary (OCNMS) (overlaps Areas 1 and 2), Greater Farallones National Marine Sanctuary (GFNMS) (Area 5), Cordell Bank National Marine Sanctuary (CBNMS) (Area 5), and Monterey Bay National Marine Sanctuary (MBNMS) (Areas 5 and 6) (see Figure 26 in Appendix B). Within the Sanctuaries, certain activities may be regulated or prohibited, such as oil, gas, and mineral exploration and production; vessel operations; drilling into or dredging submerged lands; constructing, placing, or abandoning structures or materials on or in submerged lands; and discharging or depositing substances within or from beyond the boundary of the Sanctuary. Sanctuary management of these activities may provide additional protection for killer whales in these areas.

There are a number of active commercial, recreational, and tribal fisheries for salmon and other species throughout Southern Resident killer whale critical habitat. Areas 1 and 2 overlap with the off-reservation usual and accustomed (U&A) fishing grounds of four tribes (Makah, Quileute, Hoh, and Quinault Tribes) off the coast of Washington. Other tribes in Washington, Oregon, and California have traditional resources (e.g., salmon that migrate upstream into inland waters) or participate in coastal fisheries or research in Areas 1-5.

The eastern boundary of the Navy's NWTRC offshore OPAREA is 12 nm (22.2 km) offshore for most of its length, except where it abuts the coastline (or includes the surf zone) in parts of the Washington coast.[9] The offshore OPAREA overlaps approximately 31% of critical habitat Area 1, 79% of Area 2, 32% of Area 3, and 5% of Area 4. Satellite-tagged Southern Resident killer whales spent an estimated 15.0% of the total time they were monitored in the eastern portion of Warning Area W-237 within the offshore OPAREA, which correspond with Areas 1 and 2. Off Oregon and California (corresponding to Areas 3-5), more than 75% of the tagged whales' locations were closer to shore than the OPAREA boundary (Hanson *et al.* 2017).

There is substantial vessel traffic along the U.S. West Coast, particularly around entrances to major ports (Strait of Juan de Fuca, Grays Harbor, Columbia River, Coos Bay, Humboldt Bay, San Francisco Bay) (Figure 27 in Appendix B). Traffic separation schemes (TSS) establish shipping lanes into the Strait of Juan de Fuca (northern end of Areas 1 and 2) and approaching

[9] See the Final ESA Section 4(b)(2) Report (NMFS 2021a) part of this area is excluded from critical habitat designation due to national security concerns in the final critical habitat designation.

San Francisco (Area 5), which limit the co-occurrence of ships and whales by restricting traffic that would otherwise be more widely distributed. A voluntary Area to Be Avoided designated within the northern portions of Areas 1 and 2 keeps large vessels (>400 gross tons) and those that carry oil or hazardous materials in bulk about 25 miles offshore. GFNMS and CBNMS have implemented voluntary speed restrictions requesting vessels slow-down to ten knots or less only in one of the three lanes at the approach to San Francisco Bay (Area 5). In 2000, the IMO adopted recommended shipping tracks through MBNMS (Areas 5 and 6) to guide coastal shipping along routes far enough from shore to allow for effective emergency response in the event of a mishap. Though the vessel tracks are not binding by federal law, failure to follow the recommendations subject ship operators to potential added liability should a vessel operating outside the tracks become involved in an incident that results in environmental harm.

Vessels carrying crude oil and refined petroleum products generally travel farther from shore than the boundaries of the critical habitat, except when entering or leaving ports. Coastal and inland tankers and barges generally travel along the West Coast between terminals in Seattle/Tacoma (Areas 1 and 2), Portland (Areas 1 and 2), and the San Francisco Bay area (Area 5) (Figure 28 in Appendix B). Oil spills into the marine environment (from vessels or other sources, such as pipelines) have occurred in each of the six areas, but the largest concentration is in the southern portion of Area 5 (Figure 29 in Appendix B); 31% of marine oil spill incidents from 1971-2017 within the coastal critical habitat occurred in Area 5, followed by Areas 3 (21%) and 1 (20%). The largest spills of crude oil into the marine environment since 2002 have been in California (Stephens 2017), but spills over 1,000 gallons have occurred in each area, particularly Areas 1 and 2 (Figure 30 in Appendix B).

There are numerous thermoelectric power plants adjacent to or upstream from the critical habitat, but they are concentrated landward of Areas 5 and 6, as well as Area 1 (Figure 31 in Appendix B).

There are currently no FERC-approved LNG terminals within the critical habitat, but the Jordan Cove LNG terminal has been proposed for the port of Coos Bay in Coos County, Oregon (FERC 2018c), which is adjacent to Area 3.

There are currently no renewable energy leases in the OSC off the U.S. West Coast, but one wave energy project is in the pre-application process for a license. The Pacific Marine Energy Center South Energy Test Site Research Facility Project, located approximately 5 nautical miles (9.3 km) offshore of Newport, Oregon, falls within Area 3 (FERC 2018b). Additionally, BOEM and the State of California are planning for potential leasing for offshore wind in federal waters off California just south of Area 6 (BOEM 2018a).

There are currently no marine mineral leases in the OCS off the U.S. West Coast, but an ongoing assessment of sand resources in state and federal waters off California is being conducted to determine if the resources within this location will be suitable for coastal restoration and beach renourishment projects. One sand inventory area, the San Francisco Littoral Cell, is located in Area 5 (BOEM 2017).

EPA-designated ocean dredged material disposal sites are located in Areas 1-5 (Table 7 in Appendix B). The largest of these sites, 10.59 sq mi (27.4 sq km) with an average depth of 245 ft (75 m), is located in Area 2.

As of May 2016, there were two operational and one idle desalinization plants located on the coast adjacent to Area 6. An additional three plants are proposed near the Monterey Bay and Moss Landing area, ranging from plant capacity of 6.4 to 25 million gallons per day (Pacific Institute 2016).

A query of the EPA's Enforcement and Compliance History Online Water Pollutant Loading Tool (https://echo.epa.gov/trends/loading-tool/water-pollution-search/) shows that in 2016 in Washington there were 47 publicly owned major wastewater treatment facilities discharging into waterways or watersheds where aquatic ESA-listed species are present, including but not limited to salmon. In Oregon there were 49, and 176 in California. If this is expanded to also include industrial point sources, the number of major facilities increases to 73 in Washington, 68 in Oregon, and 253 in California.

Concentrations of DDT detected in sediments and marine biota are notably higher in central and southern California than the rest of the coast (Jarvis *et al.* 2007, Blasium & Goodmnalowe 2008, Kimbrough *et al.* 2008). These higher levels of DDTs in California are due to heavy agricultural use of DDT before its ban in the 1970s, as well as the long term significant DDT discharges from a manufacturing plant (Eganhouse *et al.* 2000, Bay *et al.* 2003). While still high, the average concentrations in these areas is declining (Sericano *et al.* 2014).

VIII. Unoccupied Areas

Critical habitat designations may include "specific areas outside the geographical area occupied" if the areas are determined by the Secretary to be "essential for the conservation of the species" (ESA section 3(5)(A)(ii)). The recent "5-Year Review for Southern Resident Killer Whales" has not identified any unoccupied areas essential to the conservation of the species (NMFS 2016b).

We have considered potential future impacts climate change might have on the geographical area occupied by Southern Residents in accordance with NMFS guidance on the treatment of climate change in NMFS ESA decisions (NMFS 2016a). Impacts would primarily affect the prey feature as described below.

Southern Resident killer whales might shift their distribution in response to climate-related changes in their salmon prey. Climatic conditions affect salmonid abundance, productivity, spatial structure, and diversity through direct and indirect impacts at all life stages (e.g., (Independent Science Advisory Board 2007, Lindley *et al.* 2007, Crozier *et al.* 2008, Moyle *et al.* 2013, Wainwright & Weitkamp 2013). Studies examining the effects of long-term climate change to salmon populations have identified a number of common mechanisms by which climate variation is likely to influence salmon sustainability. These include direct effects of temperature such as mortality from heat stress, changes in growth and development rates, and disease resistance. Changes in the flow regime (especially flooding and low flow events) also affect survival and behavior. Expected behavioral responses include shifts in seasonal timing of important life history events, such as the adult migration, spawn timing, fry emergence timing, and the juvenile migration. Indirect effects on salmon mortality, growth rates and movement behavior are also expected to follow from changes in the freshwater habitat structure and the invertebrate and vertebrate community, which governs food supply and predation risk (Petersen & Kitchell 2001, Independent Science Advisory Board 2007, Crozier *et al.* 2008).

In the marine ecosystem, salmon may be affected by warmer water temperatures, increased stratification of the water column, intensity and timing changes of coastal upwelling, loss of coastal habitat due to sea level rise, ocean acidification, and changes in water quality and freshwater inputs (Independent Science Advisory Board 2007, Mauger *et al.* 2015). Salmon marine migration patterns could be affected by climate-induced contraction of thermally suitable habitat. Abdul-Aziz *et al.* (2011) modeled changes in summer thermal ranges in the open ocean for Pacific salmon under multiple IPCC warming scenarios. For chum, pink, coho, sockeye and steelhead, they predicted contractions in suitable marine habitat of 30-50% by the 2080s, with an even larger contraction (86-88%) for Chinook salmon under the medium and high emissions scenarios. Northward range shifts are a climate response expected in many marine species, including salmon (Cheung *et al.* 2015). However, salmon populations are strongly differentiated in the northward extent of their ocean migration, and hence will likely respond individualistically to widespread changes in sea surface temperature. Recent analysis ranked the vulnerability of West Coast salmon stocks to climate change and, of the top priority stocks for Southern Residents (NMFS and WDFW 2018), Puget Sound Chinook, Snake River Spring/Summer-run Chinook, Spring-run Chinook salmon stocks in the interior Columbia and Willamette River basins, and California Central Valley Chinook stocks, were ranked as “high” or “very high” vulnerability to climate change (Crozier *et al.* 2019). Additionally, new analysis for the Snake River Spring/Summer-run Chinook salmon ESU predicts substantial declines in abundance due to climate change for this ESU over the next 2-3 decades based on recent life-cycle modeling (NMFS 2020c).

Furthermore, recent modeling research has shown variation in the impacts of marine warming on Fall-run Chinook salmon distribution depending on stock, resulting in future region-specific changes in salmon abundance. Shelton *et al.* (2021) used a Bayesian state-space model to model ocean distribution of Fall-run Chinook salmon stocks in the Northeast Pacific, paired with data on sea surface temperature associated with each stock and future ocean climate predictions, to predict future distribution of Chinook salmon related to changing sea surface temperature in 2030-2090. In warm years, modeled Klamath, Columbia River (upriver bright run, lower, middle), and Snake River stocks shifted further North, while California Central Valley stock shifted South. Notably, Columbia River and Snake River Fall-run Chinook are in the top 10 priority stocks for Southern Residents (NMFS and WDFW 2008). Predicted future shifts in distributions due to warming led to future increases in ocean salmon abundance off northern British Columbia and central California, no changes off Oregon, Southern British Columbia, and Alaska, and declines in abundance off Washington and northern California.

Salmon have adapted to a wide variety of climatic conditions in the past, and thus inherently could likely survive substantial climate change at the species level in the absence of other anthropogenic stressors. Currently, the adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these ESUs. Adapting to climate change may eventually involve changes in multiple life history traits and/or local distribution, and some populations or life-history variants might die out. Importantly, the character and magnitude of these effects will vary within and among ESUs.

At this time, there is uncertainty in whether or how the current geographic areas occupied by Southern Residents would change due to the effects of climate change. We have determined that there is insufficient evidence to identify unoccupied areas based on potential impacts from climate change. It will be important to continue to monitor Southern Resident killer whales and their prey to evaluate responses to climate change and ensure appropriate habitat protections.

Similarly, we do not have information that indicates unoccupied habitat in shallow areas less than 20 ft (6.1 m) deep is essential for conservation of the species. At the present time we have not identified any areas outside the geographical area occupied by the species that are essential for its conservation, and, therefore, we are not designating any unoccupied areas.

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Appendix A

Southern Resident Killer Whale Coastal Sightings

Table 5. Confirmed opportunistic coastal sightings of Southern Resident killer whales along the outer Pacific Ocean coast from California to Alaska, 1982-2016. Adapted and updated from NMFS (2008a).

Date	Location[a]	Identification[b]	Latitude (dd)	Longitude (dd)	Depth (m)	Comments	Source[c]	Critical Habitat Area[d]
31 Jan 1982	Off Barkley Sound, southwest Vancouver Island, BC	L pod	-	-	-	-	1, 2	-
4 Apr 1986	Off Westport/Grays Harbor, WA	L pod	-	-	-	-	2, 3	1 or 2
21 Oct 1987	Coal Harbour, northern Vancouver Island, BC	Part of L pod	-	-	-	Whales were far up an inlet	2	-
3 May 1989	Tofino, west-central Vancouver Island, BC	K pod	-	-	-	-	4	-
13 Sep 1989	West of Cape Flattery, WA	L pod	-	-	-	-	5	1 or 2
4 Jul 1995	Hippa Island, Queen Charlotte Islands, BC	Southern Resident	-	-	-	Stranded[e]	2	-
17 Mar 1996	3 km off Grays Harbor, WA	L pod	-	-	-	-	5	1 or 2
May 1996	Cape Scott, northern Vancouver Island, BC	Southern Resident	-	-	-	Stranded[e]	2	-
20 Sep 1996	Off Sand Point, WA (29 km south of Cape Flattery)	L pod	-	-	-	-	6, 7	1 or 2
4 Sep 1997	Carmanah Point, southwest Vancouver Island, BC	L pod	-	-	-	-	6, 7	-
Apr 1999	Off Depoe Bay, OR	L pod	-	-	-	-	2	3

Appendix A –Southern Resident Killer Whale Coastal Sightings

Date	Location[a]	Identification[b]	Latitude (dd)	Longitude (dd)	Depth (m)	Comments	Source[c]	Critical Habitat Area[d]
29 Jan 2000	Monterey Bay, CA	K and L pods	-	-	-	Feeding on fish (Chinook?)	8, 9	6
21 Mar 2000	Off Yaquina Bay, OR	L pod	-	-	-	Seen week of March 20	2	3
14 Apr 2000	Off Depoe Bay, OR	Southern Resident	-	-	-	-	7	3
14 Apr 2001	Tofino, west-central Vancouver Island, BC	L pod	-	-	-	-	2	-
15 Apr 2002	Long Beach, WA	L60	-	-	-	Stranded	7, 10	1 or 2
27 Apr 2002	Tofino, west-central Vancouver Island, BC	L pod	-	-	-	-	2	-
12 May 2002	Tofino, west-central Vancouver Island, BC	L pod	-	-	-	-	2	-
13 Mar 2003	Monterey Bay, CA	L pod	-	-	-	-	8, 11	6
30 May 2003	Langara Island, northern Queen Charlotte Islands, BC	L pod	-	-	-	-	12	-
11 Mar 2004	Off Grays Harbor, WA	L pod	-	-	-	-	13	1 or 2
13 Mar 2004	Off Cape Flattery, WA	J pod	-	-	-	Whales were exiting the Strait of Juan de Fuca	13	1 or 2
17 May 2004	Tofino, west-central Vancouver Island	K and L pods	-	-	-	-	12	-

Appendix A –Southern Resident Killer Whale Coastal Sightings

Date	Location[a]	Identification[b]	Latitude (dd)	Longitude (dd)	Depth (m)	Comments	Source[c]	Critical Habitat Area[d]
16 Feb 2005	Farallon Islands, CA	L pod	-	-	-	-	7	5
22 Mar 2005	Fort Canby-North Head, WA	L pod	-	-	-	-	13	1 or 2
9 Jun 2005	West of Cape Flattery, WA, in Canadian waters	L pod	-	-	-	-	15	-
7 Sep 2005	West of Cape Flattery, WA, in Canadian waters	L pod	-	-	-	-	13	-
23 Oct 2005	Off Columbia River	K pod	-	-	-	-	14	1 or 2
29 Oct 2005	Off Columbia River	K and L pods	-	-	-	-	14	1 or 2
26 Jan 2006	Pt. Reyes, CA	L pod	-	-	-	-	15	5
18 Mar 2006	North of Neah Bay, WA, in Canadian waters	J pod	48.3003	-124.2668	171.3	Whales were exiting the Strait of Juan de Fuca	13	-
30 Mar 2006	Off Columbia River	K and L pods	46.1653	-124.2848	97.2	-	13	2
6 Apr 2006	Off Westport, WA	K and L pods	46.9682	-124.2353	21.9	-	16	1
8 May 2006	Off Brooks Peninsula, northwest Vancouver Island, BC	L pod	50.1167	-127.95	-		2	-
24 Jan 2007	Off San Francisco, CA	K pod	-	-	-	-	7, 8	5
18 Mar 2007	Off Fort Bragg, CA	L pod	-	-	-	-	7	5
24-25 Mar 2007	Monterey Bay, CA	K and L pods	36.7083	-121.91	90.3	-	8	6

Appendix A –Southern Resident Killer Whale Coastal Sightings

Date	Location[a]	Identification[b]	Latitude (dd)	Longitude (dd)	Depth (m)	Comments	Source[c]	Critical Habitat Area[d]
1 Jun 2007	Chatham Strait, AK	L pod	56.56667	-134.38333	195.8		2	-
30 Oct 2007	Bodega Bay, CA	L pod	-	-	-	-	16	5
1 Dec 2007	Johnstone Strait, BC	L pod	-	-	-	-	2	-
27 Jan 2008	Monterey Bay, CA and Cypress Point, Carmel Bay, CA	L pod	-	-	-	Last seen heading south	7, 8	6
2 Feb 2008	Monterey Bay, CA	K and L pods	-	-	-	-	7, 8	6
31 Jul 2008	Between Cape Alava and Cape Flattery, WA	L pod	-	-	-	-	7, 17	1 or 2
21 Jan 2009	Off Depoe Bay, OR	L pod	-	-	-	-	7, 18	3
24 Jan2009	Off Depoe Bay, OR	L pod	-	-	-	-	7, 18, 19	3
5 Mar 2009	Monterey Bay, CA	L pod	-	-	-	-	7, 8	6
7 Mar 2009	Farallon Islands, CA	L pod	-	-	-	-	7	5
26 Mar 2009	Off Westport, WA	L pod	47.01167	-124.5127	71.1	-	13	2[f]
27 Mar 2009	Off Columbia River	L pod	46.263	-124.2283	61.1	-	13	2
4 Jun 2009	Off WA coast west of Lake Ozette	L12 subpod	48.055	-124.9	67.6	-	20	2
24 Jan 2010	3.2 mi west of Sea Lion Caves near Florence , OR	K pod	44	-124.9	85.3	-	21	3

Appendix A –Southern Resident Killer Whale Coastal Sightings

Date	Location[a]	Identification[b]	Latitude (dd)	Longitude (dd)	Depth (m)	Comments	Source[c]	Critical Habitat Area[d]
15 Apr 2010	Off Taholah, WA	L pod	47.3944	-124.6979	105.5	-	16	2
10 Feb 2011	Monterey Bay, CA	L pod	-	-	-	-	7, 8	6
14 Feb 2011	Off San Francisco, CA	L pod	-	-	-	-	22	5
24 Mar 2011	WA coast near Umatilla Reef	K12 subpod	48.1983	-124.7482	31.0	-	7, 17	1
29 Apr 2012	Off Westport, WA	K and L pods	46.9495	-124.4283	63.1	-	16	2
21 May 2012	Off Depoe Bay, OR	L pod	-	-	-	-	13	3
15 Jun 2012	WA coast, 20 nmi offshore of La Push	L pod	-	-	-	-	16	2
24 Jul 2012	West of Ucluelet, Vancouver Island, BC	L84	48.919917	-125.8201333	55.7	-	23	-
2 Aug 2012	23 nm WNW of Cape Alava, WA	J pod	-	-	-	-	24	2
11 Aug 2012	2 nmi off Garrard Island Group, west-central Vancouver Island, BC	L pod	-	-	-	-	23	-
2 Feb 2013	25 km southwest of Willapa Bay, WA	L12 subpod	46.53	-124.35	75.5	-	13	2
14 Feb 2013	Off Yaquina Head Lighthouse, OR	L pod	44.6943	-124.1403	42.4	-	25	3
12 Jun 2013	1.75 mi southwest of Cleland Island, Vancouver Island, BC	K pod	49.17262	-126.21883	51.8	-	7, 26	-

Appendix A –Southern Resident Killer Whale Coastal Sightings

Date	Location[a]	Identification[b]	Latitude (dd)	Longitude (dd)	Depth (m)	Comments	Source[c]	Critical Habitat Area[d]
20 Jun 2013	Off Uclulet, Vancouver Island, BC	L88	-	-	-	-	23	-
16 Oct 2013	Off Vargas Island, west Vancouver Island, BC	K21				-	23	-
28 Apr 2014	CA coast, 9 km west of Eel River mouth	K and L pods	40.6401	-124.4131	37.9	-	27	4
17 Jun 2014	1 mi off Sea Lion Rocks near Uclulet, Vancouver Island, BC	L84	-	-	-	-	23	-
17 Feb 2015	Off Cape Flattery, WA	K and L pods	48.34567	-124.898	313.4	Satellite tag deployed on L84	13	2[f]
23 Feb 2016	Off La Push, WA	L pod	47.9083	-124.7767	48.7	Satellite tag deployed on L95	13	1
27 Feb 2016	WA coast just north of Columbia River	K and L pods	46.274	-124.2178	52.6	-	13	2
7 Mar 2016	Off Cape Flattery, WA	J pod	48.3992	-124.8435	272.2	-	13	2

a Location abbreviations: CA - California, WA - Washington, OR - Oregon, B.C. - British Columbia, AK – Alaska.
b Pod listings do not imply that the entire pod was present.
c Sources: 1, Ford et al. (2000); 2, J. K. B. Ford, Pacific Biological Station, Department of Fisheries and Oceans Canada, Nanaimo, B.C.; 3, Bigg *et al.* (1990); 4, The Whale Museum sighting archives (1978–2006), Friday Harbor, WA; 5, Calambokidis *et al.* (2004); 6, P. Gearin, National Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA; 7, D. Ellifrit, K. Balcomb, and M. Malleson, Center for Whale Research, Friday Harbor, WA; 8, N. A. Black, Monterey Bay Whale Watch, Pacific Grove, CA; 9, Black *et al.* (2001); 10, D. Duffield, Portland State University, Portland, OR; 11, Monterey Bay Whale Watch (2003); 12, M. Joyce, Fisheries and Oceans Canada, Vancouver, B.C.; 13, Northwest Fisheries Science Center, Seattle, WA; 14, Southwest Fisheries Science Center, La Jolla, CA; 15, S. Allen, National Park Service, Pt. Reyes, CA; 16, Cascadia Research Collective, Olympia, WA; 17, J. Scordino and A. Akmajian, Makah Tribe, Neah Bay, WA; 18, M. Grover and L. Taylor, Whale Watching Center, Depoe Bay, OR; 19, C. Newell, Whale Research EcoExcursions, Depoe Bay, OR; 20, F. Pierson & J Hubbell, S/V Storm Petrel, report to Orca Sightings Network; 21, N. Edwards, Florence, OR, report to Orca Sightings Network; 22, J. Smith, Naked Whale Research, Fort Bragg, CA; 23, R. Palm, Strawberry Isle Marine Research Society, Tofino, B.C.; 24, R. Fletcher, NOAA Olympic

Coast National Marine Sanctuary, Port Angeles, WA; 25, B. Lagerquist and B. Mate, Oregon State University, Newport, OR; 26, The Whale Centre, Tofino, B.C., 27, Bio-Waves, Inc., Encinitas, CA.

d Sightings off the coast of Washington without location coordinates allowing assignment an area based on depth are shown as "Area 1 or 2." For satellite tagged whales: initial sightings in coastal waters during which the tag was applied are included in this Appendix (L84 and L95); application of tag to L88 (off the coast of Oregon) is not included in this Appendix because researchers were guided to the location based on data from K25's tag, so it not considered independent; subsequent coastal sightings of all tagged whales while the tags were actively transmitting are not included in this Appendix because they are not independent/opportunistic.

e Carcass identified by genetic testing.

f Initial sighting in Area 2, but prey samples collected during same encounter in Area 1.

Table 6. Number of opportunistic coastal sightings by critical habitat area, summarized from Table 5**.**

Critical Habitat Area	# Sightings
1	3
2	12
1 or 2	11
3	8
4	1
5	7
6	7
Alaska	1
Canada outer coast	22
Total	72
Total in Critical Habitat	49

Appendix B

Information Supporting Special Management Considerations

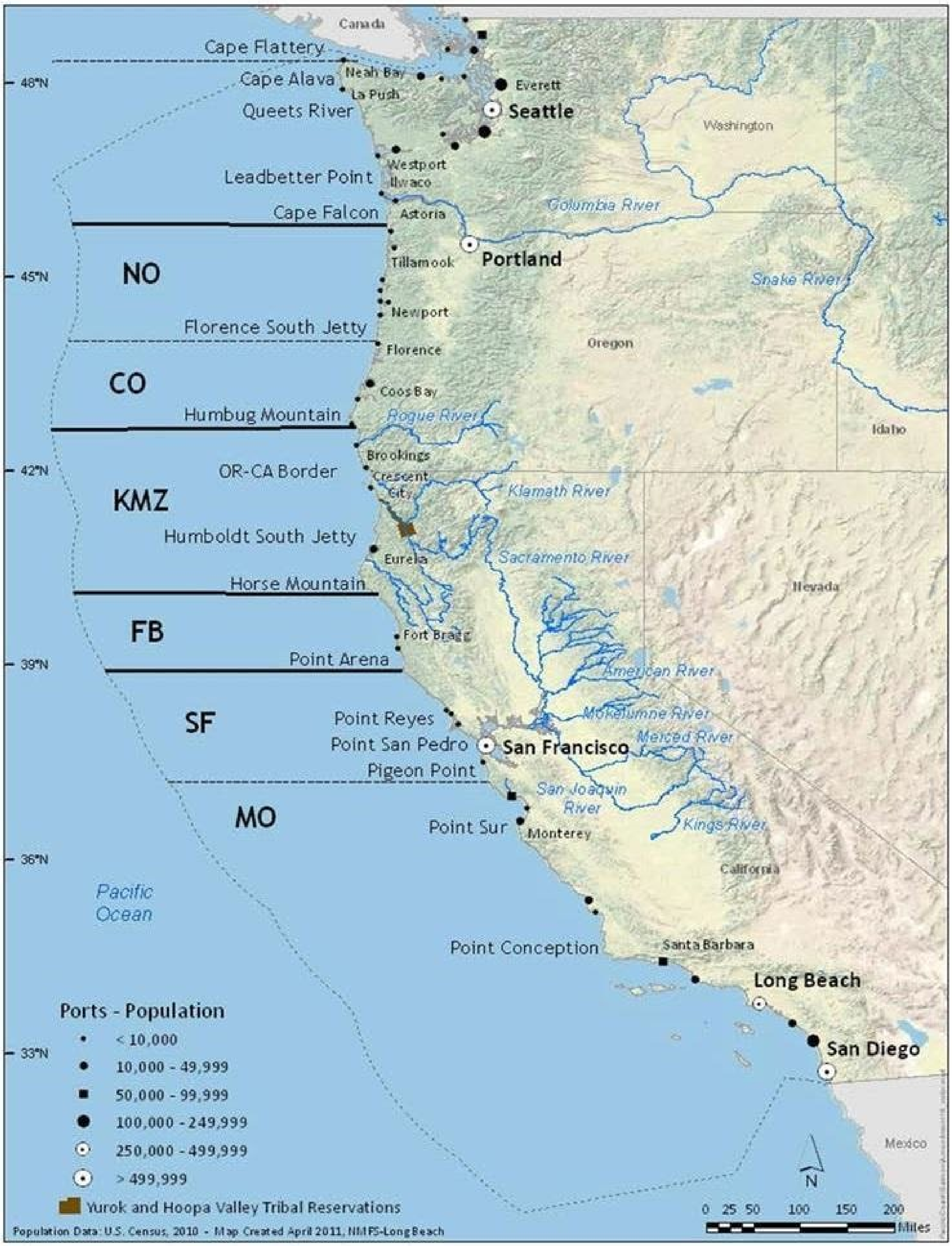
Canada
Cape Flattery
48°N
Cape Alava
Neah Bay
La Push
Everett
Seattle
Queets River
Washington
Leadbetter Point
Westport
Ilwaco
Cape Falcon
Astoria
Columbia River
Portland
NO
45°N
Tillamook
Snake River
Newport
Florence South Jetty
Florence
Oregon
CO
Coos Bay
Humbug Mountain
Rogue River
Idaho
Brookings
42°N
OR-CA Border
Crescent City
KMZ
Klamath River
Humboldt South Jetty
Eureka
Sacramento River
Horse Mountain
Nevada
FB
Fort Bragg
39°N
Point Arena
American River
SF
Point Reyes
Mokelumne River
Point San Pedro
San Francisco
Merced River
Pigeon Point
San Joaquin River
MO
Point Sur
Monterey
Kings River
36°N
California
Pacific Ocean
Point Conception
Santa Barbara
Long Beach
Ports - Population
< 10,000
10,000 - 49,999
50,000 - 99,999
100,000 - 249,999
250,000 - 499,999
> 499,999
33°N
San Diego
Mexico
N
Yurok and Hoopa Valley Tribal Reservations
0 25 50 100 150 200 Miles
Population Data: U.S. Census, 2010 - Map Created April 2011, NMFS-Long Beach

Figure 25. Map of major management boundaries in common use since 2000. North Oregon (NO), Central Oregon (CO), Klamath Management Zone (KMZ), Fort Bragg (FB), San Francisco (SF), and Monterey (MO).

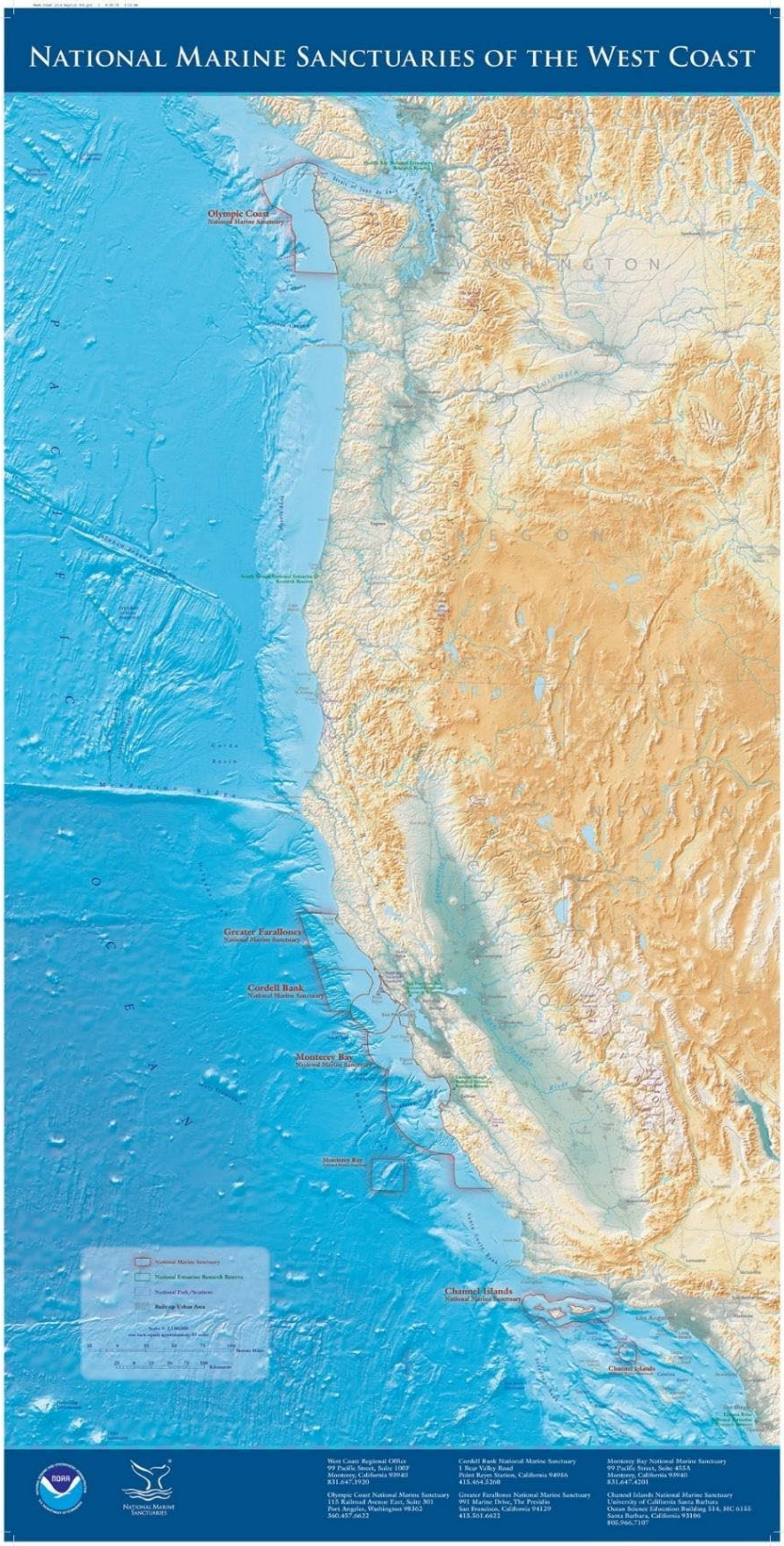
NATIONAL MARINE SANCTUARIES OF THE WEST COAST
Olympic Coast
National Marine Sanctuary
WASHINGTON
OREGON
Greater Farallones
National Marine Sanctuary
Cordell Bank
National Marine Sanctuary
Monterey Bay
National Marine Sanctuary
Channel Islands
National Marine Sanctuary
Channel Islands
West Coast Regional Office
99 Pacific Street, Suite 100F
Monterey, California 93940
831.647.1920
Olympic Coast National Marine Sanctuary
115 Railroad Avenue East, Suite 301
Port Angeles, Washington 98362
360.457.6622
Cordell Bank National Marine Sanctuary
1 Bear Valley Road
Point Reyes Station, California 94956
415.464.5260
Greater Farallones National Marine Sanctuary
991 Marine Drive, The Presidio
San Francisco, California 94129
415.561.6622
Monterey Bay National Marine Sanctuary
99 Pacific Street, Suite 455A
Monterey, California 93940
831.647.4201
Channel Islands National Marine Sanctuary
University of California Santa Barbara
Ocean Science Education Building 514, MC 6155
Santa Barbara, California 93106
805.966.7107
NATIONAL MARINE SANCTUARIES

Figure 26. West Coast National Marine Sanctuaries. From: https://sanctuaries.noaa.gov/about/maps.html. Accessed 26 March 2018.

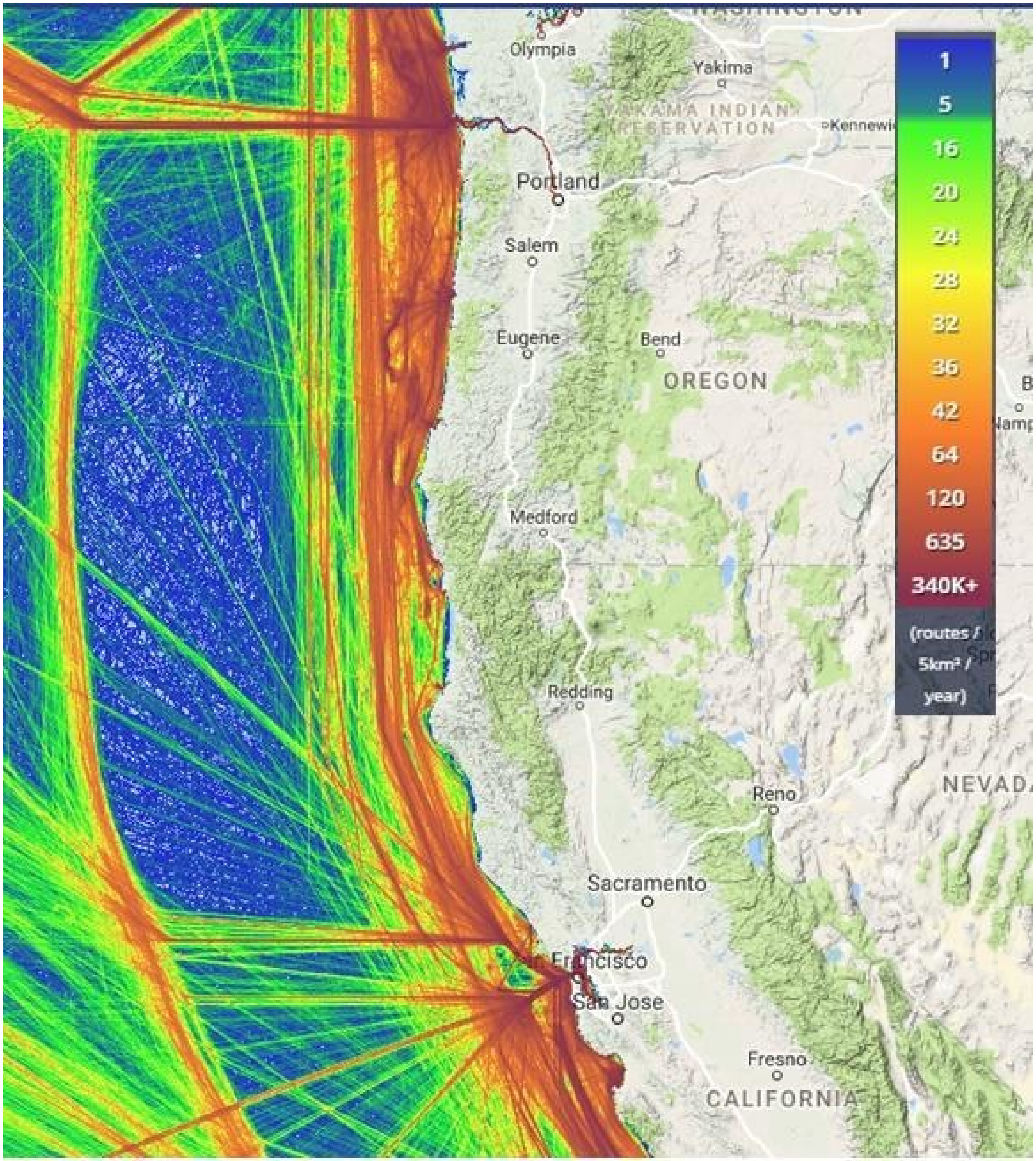

Figure 27. Ship traffic patterns derived from 2017 Automatic Identification System (AIS) data. From: http://www.marinetraffic.com/en/ais/home/centerx:-123.1/centery:41.5/zoom:6. Accessed 21 March 2018.

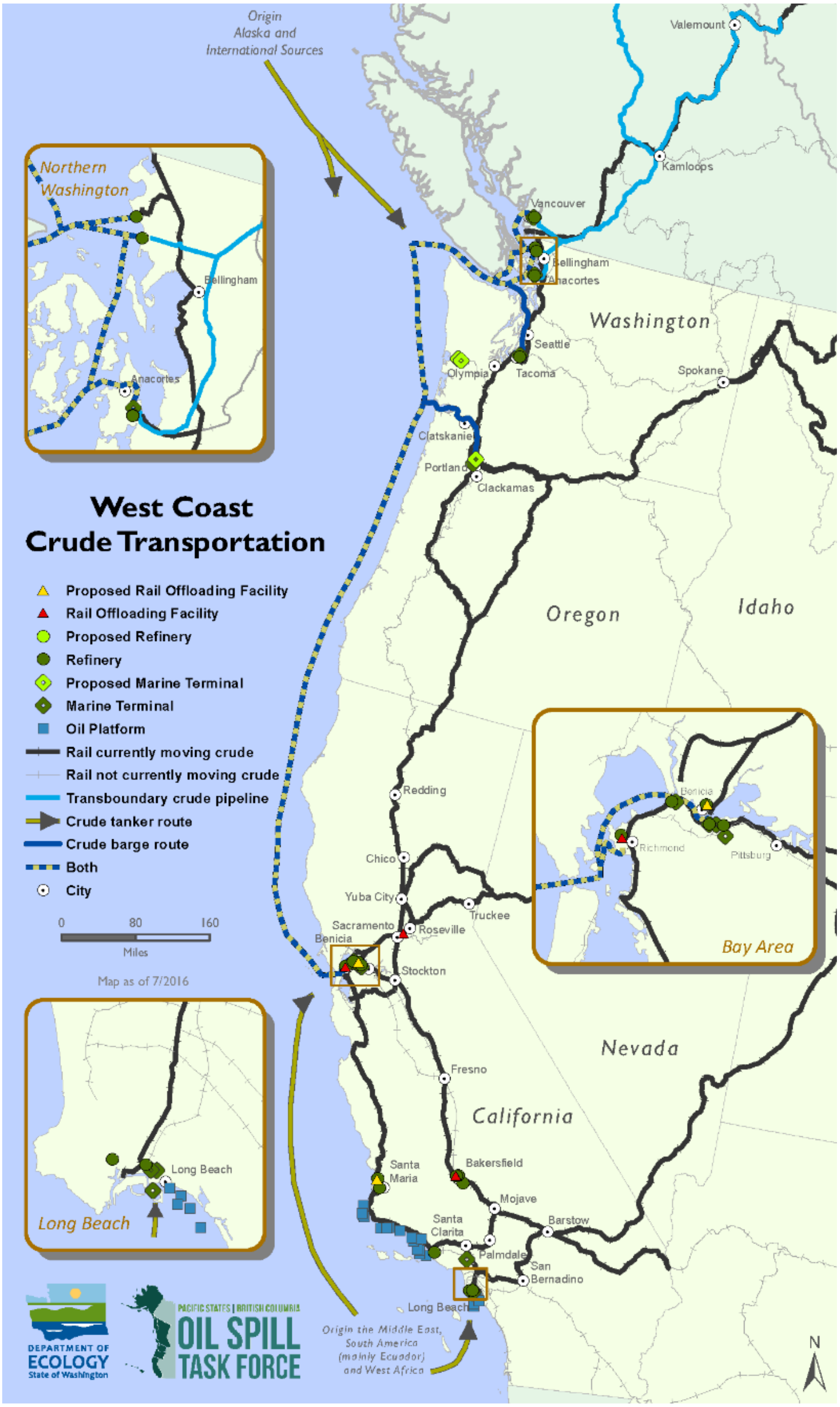
West Coast
Crude Transportation
Proposed Rail Offloading Facility
Rail Offloading Facility
Proposed Refinery
Refinery
Proposed Marine Terminal
Marine Terminal
Oil Platform
Rail currently moving crude
Rail not currently moving crude
Transboundary crude pipeline
Crude tanker route
Crude barge route
Both
City
0 80 160
Miles
Map as of 7/2016
Origin Alaska and International Sources
Origin the Middle East, South America (mainly Ecuador) and West Africa
Northern Washington
Bay Area
Long Beach
Washington
Oregon
Idaho
Nevada
California
Valemount
Kamloops
Vancouver
Bellingham
Anacortes
Seattle
Tacoma
Olympia
Spokane
Clatskanie
Portland
Clackamas
Redding
Chico
Yuba City
Sacramento
Benicia
Roseville
Truckee
Stockton
Richmond
Pittsburg
Fresno
Santa Maria
Bakersfield
Mojave
Barstow
Santa Clarita
Palmdale
San Bernadino
Long Beach
N
DEPARTMENT OF ECOLOGY State of Washington
PACIFIC STATES | BRITISH COLUMBIA OIL SPILL TASK FORCE

Figure 28. Map of current rail routes, interstate pipelines, and barges transporting crude oil across the West Coast. From: http://oilspilltaskforce.org/wp-content/uploads/2017/02/2017_oil_movement_westCoast-2-10-17.pdf. Accessed 26 March 2018.

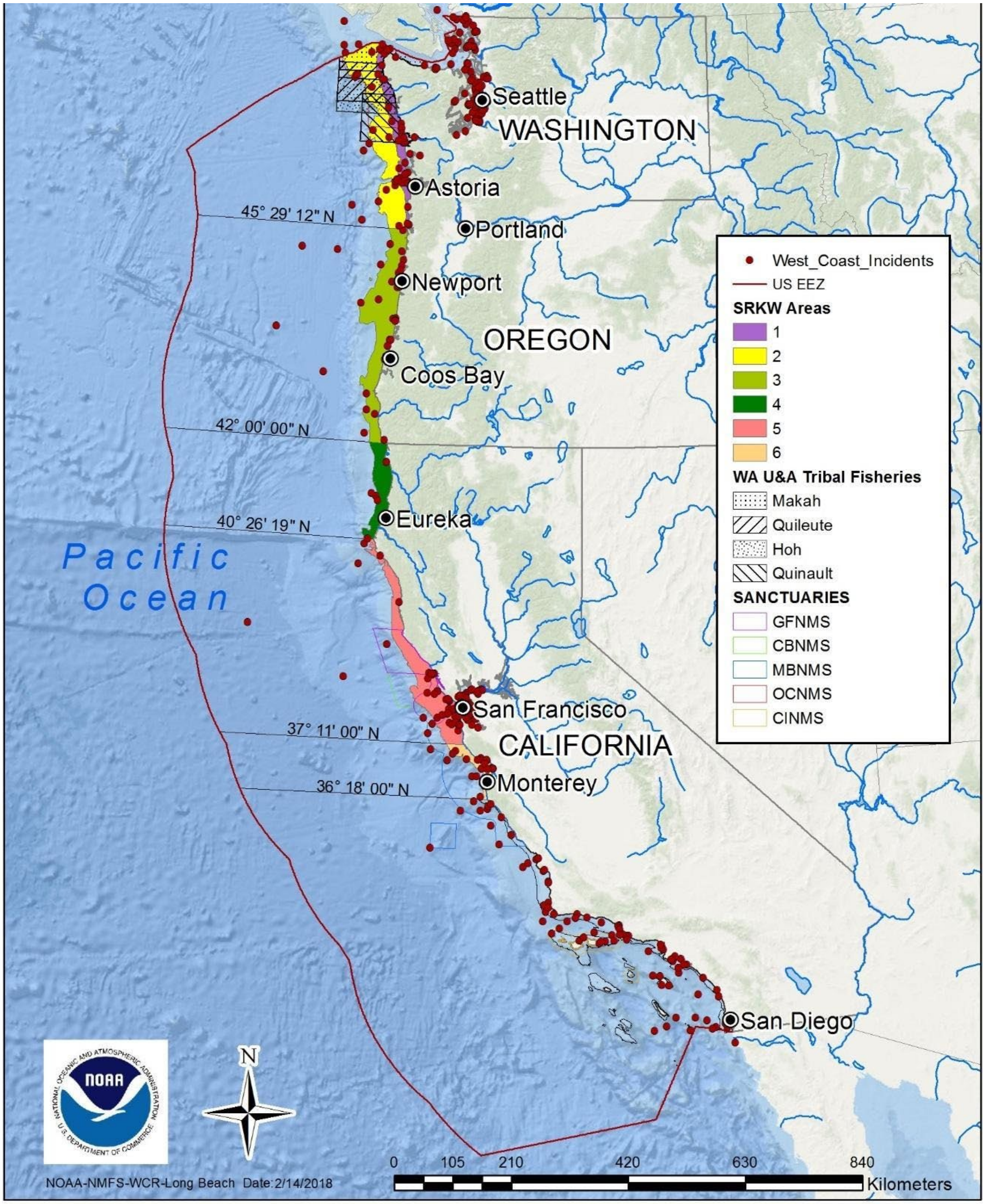

Figure 29. Marine oil spill incidents on the Pacific West Coast from 1971-2017 within newly designated critical habitat. Raw incident data include selected oil spills off U.S. coastal waters and other incidents where NOAA's Office of Response and Restoration provided scientific support for the spill response (although some older records before 1984 come from third-party databases). Raw data available from https://incidentnews.noaa.gov/raw/index. Accessed 27 December 2017.

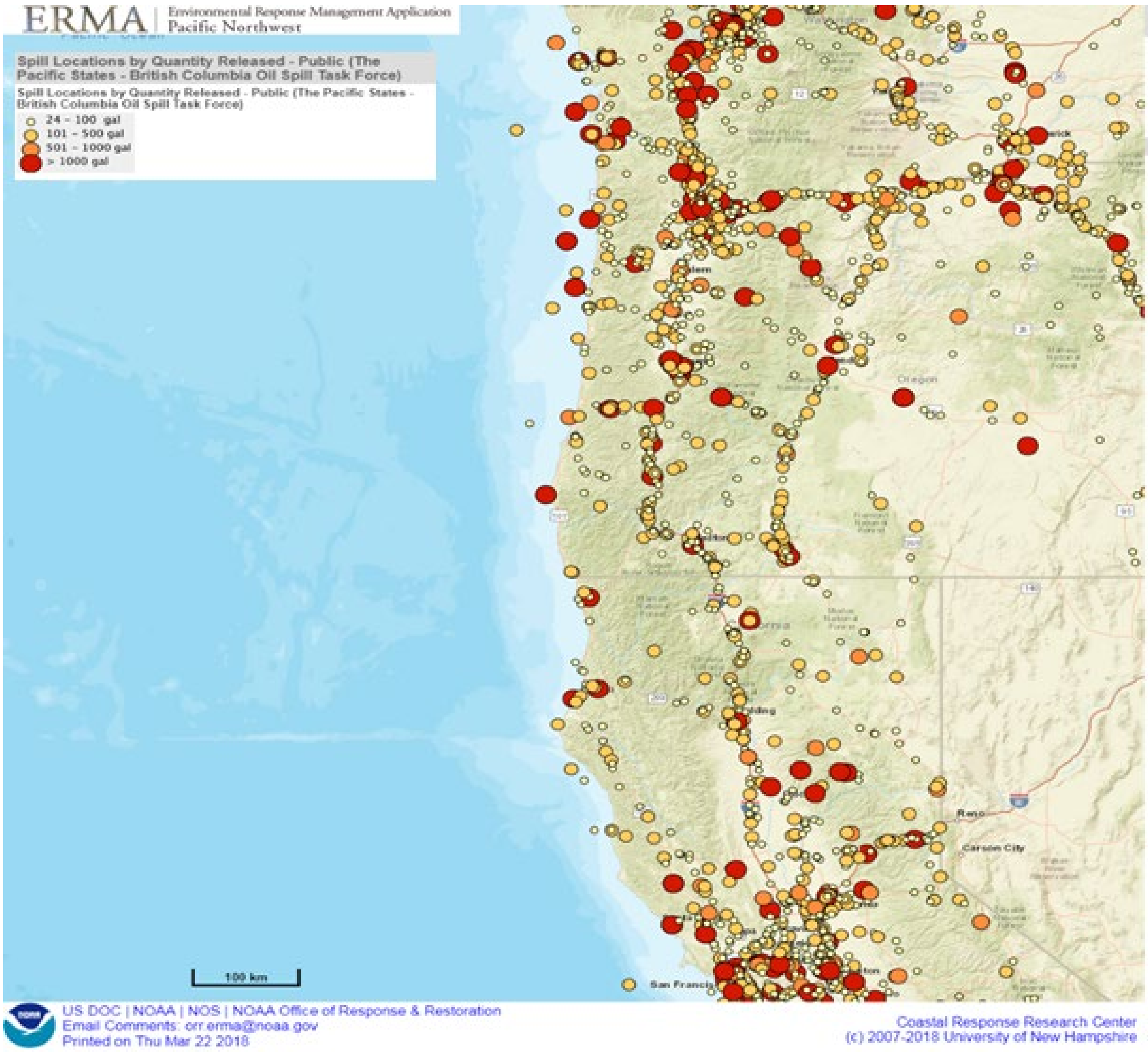

Figure 30. Oil spill locations by quantity released, 2002-2012. Data from the Pacific States – British Columbia Oil Spill Task Force, mapped using the Environmental Response Management Application. Available from https://erma.noaa.gov/northwest/erma.html#/view=1457. Accessed 26 March 2018.

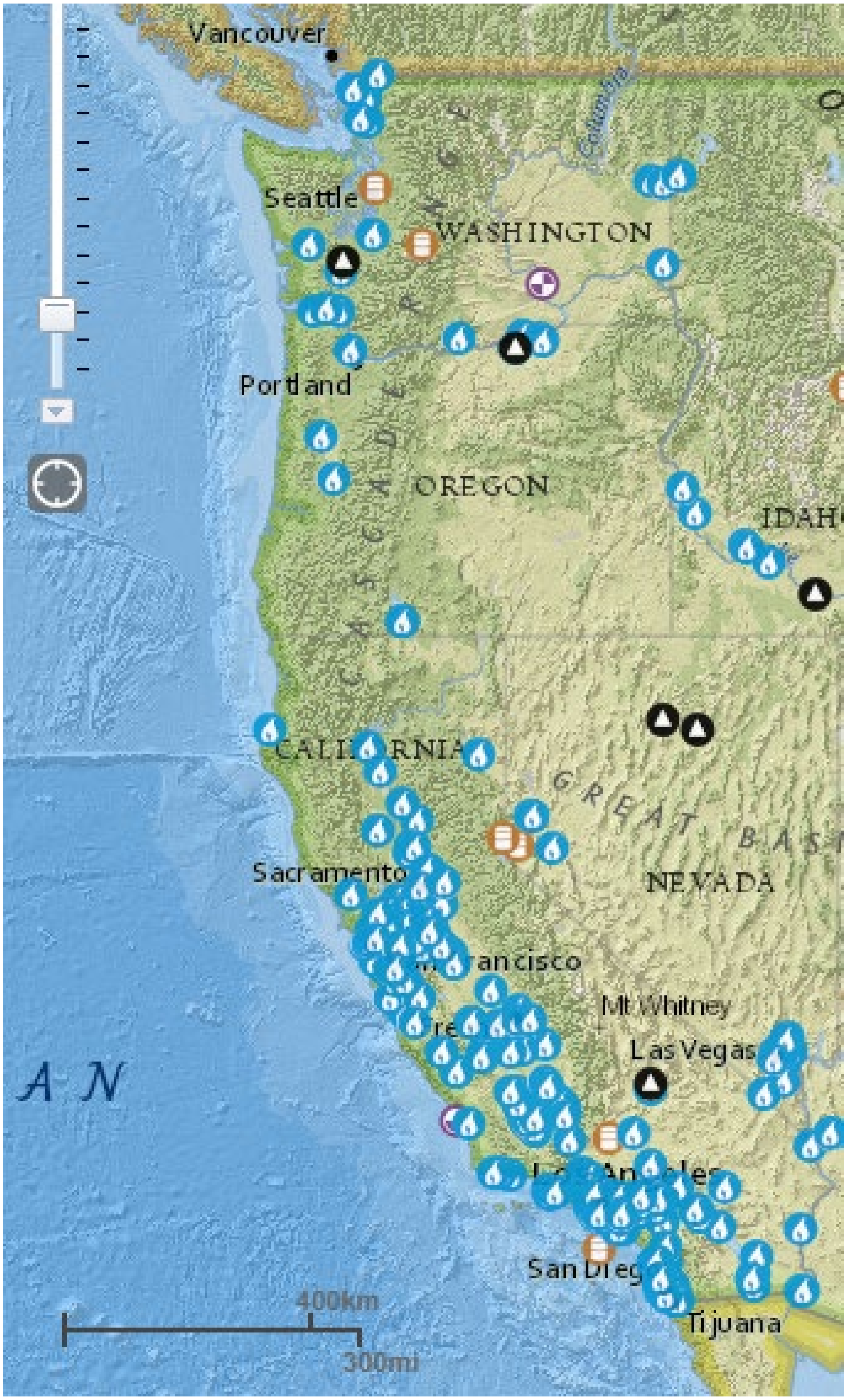

Figure 31. Map of power plants on the U.S. West Coast. Other types of power plants that may or may not be thermoelectric, including biomass, geothermal, hydroelectric, solar, wind, pumped storage, and other,

are not shown. Adapted from the U.S. Energy Mapping System, https://www.eia.gov/state/maps.php. Accessed 23 March 2018.

Table 7. Dredge Material Sites. Adapted from EPA's Ocean Disposal Map. https://www.epa.gov/ocean-dumping/ocean-disposal-map. Accessed 1 November 2017.

Critical Habitat Area Overlap	Site Name	EPA Region	Average Depth in Feet (m)	Area in Sq. Miles (sq. km)	Date Designated
1	Grays Harbor Eight Mile Site	10	149 (45)	0.5 (1.3)	6-Aug-1990
	Grays Harbor Southwest Navigation Site	10	115 (35)	1.25 (3.24)	6-Aug-1990
	Mouth of the Columbia River, OR/WA Dredged Material Shallow Water Site	10	60 (18)	1.35 (3.50)	1-Apr-2005
2	Mouth of the Columbia River, OR/WA Dredged Material Deep Water Site	10	245 (75)	10.59 (27.4)	1-Apr-2005
3	Yaquina North ODMD Site	10	132 (40)	0.71 (1.84)	9-Oct-2012
	Yaquina South ODMD Site	10	132 (40)	0.71 (1.84)	9-Oct-2012
	North Siuslaw River, OR Dredged Material Disposal Site	10	72 (22)	0.26 (0.67)	1-Jun-2010
	South Siuslaw River, OR Dredged Material Disposal Site	10	99 (30)	0.16 (0.41)	1-Jun-2010
	North Umpqua River, OR Dredged Material Disposal Site	10	75 (23)	0.68 (1.76)	26-May-2009
	South Umpqua River, OR North Dredged Material Disposal Site	10	75 (23)	0.86 (2.23)	26-May-2009
	Coos Bay OR Dredged Material Site F	10	94 (29)	3.18 (8.24)	11-May-2006
	Coos Bay, OR Dredged Material Site H	10	180 (55)	0.13 (0.34)	22-Sep-1986
	Coos Bay, OR Dredged Material Site E	10	56 (17)	0.13 (0.34)	22-Sep-1986
	Coquille River Entrance, OR	10	60 (18)	0.17 (0.44)	20-Jun-1990

Critical Habitat Area Overlap	**Site Name**	**EPA Region**	**Average Depth in Feet (m)**	**Area in Sq. Miles (sq. km)**	**Date Designated**
	Rogue River, OR Dredged Material Site	10	70 (21)	0.14 (0.36)	15-May-2009
	Chetco, OR Dredged Material Site	10	69 (21)	0.09 (0.23)	19-Sep-1991
4	Humboldt Open Ocean Disposal Site (HOODS) Ocean Dredged Material Disposal Site	9	170 (52)	1 (2.6)	30-Oct-1995
5	Channel Bar Site, San Francisco, CA (SF-8)	9	42 (13)	1.22 (3.16)	12-Apr-1985