Southern Resident Killer Whales
(Orcinus orca)

5-Year Review:
Summary and Evaluation

The Northwest Fisheries Science Center conducts research off the coast of WA in 2021 to study the coastal distribution and habitat use of Southern Resident killer whales, in addition to diet studies through collection of prey and fecal samples (NMFS permit # 21348). Photo credit: Northwest Fisheries Science Center.

National Marine Fisheries Service
West Coast Region
Seattle, WA

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Table of Contents

LIST OF ACRONYMS

CWR	Center for Whale Research
CWWLP	Commercial Whale Watch Licensing Program
CTC	Concurrent Technologies Corporation
DARRP	Damage Assessment, Remediation, and Restoration Program
DDT	Dichlorodiphenyltrichloroethane
DFO	Department of Fisheries and Oceans Canada
DPS	Distinct Population Segment
DTAG	Digital acoustic tag
EC	Environment Canada
ECHO	Enhancing Cetacean Habitat and Observation
EEZ	Exclusive Economic Zone
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FRAM	Fishery Regulation Assessment Model
M3	Marine Mammal Monitoring Project
MMPA	Marine Mammal Protection Act
NFWF	National Fish and Wildlife Foundation
NMFS	National Marine Fisheries Service
NMMF	National Marine Mammal Foundation
NMMSN	Northwest Marine Mammal Stranding Network (now West Coast Marine Mammal Stranding Network)
NRKW	Northern Resident killer whale
NWACP	Northwest Area Contingency Plan
NWFSC	Northwest Fisheries Science Center
ODEQ	Oregon Department of Environmental Quality
PAH	Polycyclic aromatic hydrocarbon
PBDE	Polybrominated diphenyl ether
PCB	Polychlorinated biphenyl
PCSRF	Pacific Coastal Salmon Recovery Fund
PFMC	Pacific Fishery Management Council
POP	Persistent organic pollutant
PSP	Puget Sound Partnership
PST	Pacific Salmon Treaty
RC	NOAA Restoration Center
SA	Seattle Aquarium
SML	Sea surface microlayer
SRKW	Southern Resident killer whale
SWFSC	Southwest Fisheries Science Center
TWM	The Whale Museum
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
UW	University of Washington
VA	Vancouver Aquarium

WCR	West Coast Region
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WDOA	Washington State Department of Agriculture
WDOE	Washington State Department of Ecology
WWOANW	Whale Watch Operators Association Northwest (now Pacific Whale Watch Association)
WSP	Washington State Parks and Recreation Commission
WRAS	Whale Report Alert System

5-YEAR REVIEW
Southern Resident killer whales/*Orcinus orca*

EXECUTIVE SUMMARY

The Southern Resident killer whale Distinct Population Segment (DPS) was listed as endangered under the Endangered Species Act (ESA) in 2005. In the listing, the National Marine Fisheries Service (NMFS) identified three main threats to their survival: 1) scarcity of prey, 2) high levels of contaminants from pollution, and 3) disturbance from vessels and sound. As of 1 July 2021 after the summer census, there were only 74 individuals left in the population (CWR 2021). Since the summer census, one adult male whale (K21) is presumed dead, so at the time of this review there are currently 73 individuals in the population. Their small population size and social structure also put them at risk for a catastrophic event, such as an oil spill, that could affect the entire population. Updates regarding research and management actions for the primary threats (prey, pollution, and vessels) are discussed below and evaluated alongside recovery criteria to assess recovery progress. This review fulfills our requirement under Section 4(c)(2) of the ESA to conduct a review of listed species at least once every five years to ensure that the listing of these species remains accurate.

Despite being studied for more than 40 years, it is unclear which threat to this killer whale population is the most important for recovery. Furthermore, the threats likely interact to produce additive or synergistic effects. The Recovery Plan, therefore, addresses each of the threats based on the best available science. NMFS has linked the management actions in the Recovery Plan to research and monitoring actions to gather information to inform prioritization, refine recovery actions, identify new actions as needed, and evaluate the effectiveness of actions.

To inform recovery, an active research program is underway to gather more information about the biology of the whales, habitat use and distribution, how the different threats are impacting the whales, and to monitor the population status. The Northwest Fisheries Science Center (NWFSC) developed a research plan (NMFS 2006) that informed the monitoring and research actions in the Recovery Plan. The NWFSC conducts research on the whales, partners with various academic and non-profit research groups, coordinates with Canadian researchers, and provides information on research to the public. All of these efforts implement actions in the Recovery Plan.

Together, numerous partners have implemented research and conservation efforts for Southern Resident killer whales (SRKWs) for over a decade, including the State of Washington, tribes, the Department of Fisheries and Oceans Canada, and many others.

In 2018, Governor Jay Inslee signed an Executive Order directing Washington State agencies to take immediate actions to benefit SRKWs. He also convened a Task Force that developed recommendations for short- and long-term actions. This Task Force process highlighted the urgency for action, raised awareness, brought diverse stakeholders together, and resulted in new commitments from Washington State as a leading partner in the recovery of SRKWs. Since its inception, the Task Force has produced two reports with recommendations to support SRKW recovery, and Washington State has earmarked funding to implement the recommendations.

Implementation of these recommendations is ongoing. The Washington State Legislature has also passed bills to support SRKW recovery efforts.

Drawing on the Recovery Plan and recommendations from the Task Force, in 2021, NMFS updated an Action Plan for the SRKWs to highlight priority actions. The NMFS Species in the Spotlight initiative identifies nine species that are at high risk of extinction, including SRKWs. Priority Action Plans highlight recent progress and identify objectives for the next five years. High-priority actions for 2021-2025 are outlined in the 2021 Species in the Spotlight 5-Year Action Plan discussed in Section 1.3.5 of this review.

Findings from this 2021 species review indicate that despite the coordinated implementation of efforts over the long term, and particularly during the last five years, the SRKW DPS has not grown. While some of the downlisting and delisting criteria have been met, the overall status of the population is not consistent with a healthy, recovered population. Considering the status and continuing threats, the Southern Resident killer whales remain in danger of extinction. Therefore, the recommended classification in this 5-year review is for Southern Resident killer whales to remain listed as Endangered. This review provides an update on the status of the whales and our progress toward meeting the recovery criteria identified in the 2008 Recovery Plan.

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional or Headquarters Office: West Coast Regional Office–Chris Yates, Assistant Regional Administrator for Protected Resources, (562) 980-4007

Cooperating Science Center(s): Northwest Fisheries Science Center–Brad Hanson**,** Conservation Biology Program, (206) 860-3220

1.2 Methodology Used to Complete the Review

The NMFS West Coast Regional Office led the 5-year review and requested review by the Northwest Fisheries Science Center and Office of Protected Resources. The primary sources of information in this review include reports, peer-reviewed publications, and data available from ongoing studies and reviews that have become available since *The Recovery Plan for the Southern Resident Killer Whales (Orcinus orca)* was completed in January 2008, and since the last 5-year review was completed in 2016. In addition, Southern Resident killer whales are identified as one of NMFS Species in the Spotlight, and the associated Priority Actions Plans for 2016-2020 and 2021-2025 have informed this review.

1.3 Background

1.3.1 Federal Register Notice Announcing Initiation of this Review

86 Fed. Reg. 21282, April 22, 2021, Endangered and Threatened Species; Initiation of 5-year Review for Southern Resident Killer Whales

Upon publishing the notice of the initiation of the review in the Federal Register, NMFS solicited comments from the public, scientific community, tribes, governmental agencies, environmental organizations, industry, and any other interested parties regarding information relevant to the recovery of the endangered Southern Resident killer whale DPS. The categories of information sought included: (1) species biology, (2) habitat conditions and information, (3) status and trends of threats, (4) actions taken to benefit the species, (5) need for additional measures, (6) assessment of the recovery criteria, and (7) any other information that has become available since the species was listed in 2005 or since the last 5-year review. The comment period closed on June 21, 2021, with 30 comments submitted. Among the commenters were residents of Puget Sound, the West Coast region, and beyond; state representatives (Washington Department of Fish and Wildlife, WA Recreation and Conservation Office, Puget Sound Partnership, AK Department of Fish and Game); federal representatives (Bureau of Land Management); tribal agencies (Spokane Tribe of Indians); industry (Pacific Whale Watch Association); and representatives of environmental organizations, including the Wild Fish Conservancy, Whale Museum, Orca Conservancy, Orca Salmon Alliance, and Friends of The Snoqualmie Valley Trail and River. Nearly all comments expressed either support for the continuation of the DPS' Endangered listing or for increased protection for the

whales. A large majority of the comments focused on prey as the primary issue affecting the whales. Several substantive letters submitted by environmental organizations included scientific information and peer-reviewed literature considered in this 5-year status review. Many commenters urged NMFS to consider additional protections from vessel and noise disturbance and to consider the impact of contaminants on reproduction and survival. Several commenters urged the agency to support habitat restoration initiatives to assist in endangered Chinook salmon recovery.

1.3.2 Listing History

Original Listing

Federal Register notice: 70 Fed. Reg. 69903, November 18, 2005, Endangered and Threatened Wildlife and Plants: Endangered Status for Southern Resident Killer Whales
Date listed: Effective February 16, 2006
Entity listed: DPS
Classification: Endangered

1.3.3 Associated Rulemaking

Critical Habitat Designation: 71 Fed. Reg. 69054, November 29, 2006, Endangered and Threatened Species; Designation of Critical Habitat for Southern Resident Killer Whales
Protective Regulations: 76 Fed. Reg. 20870, April 14, 2011, Protective Regulations for Killer Whales in the Northwest Region under the Endangered Species Act and Marine Mammal Protection Act
Critical Habitat Revision: 80 Fed. Reg. 9682, February 24, 2015, Listing Endangered or Threatened Species; 12-Month Finding on a Petition to Revise the Critical Habitat Designation for the Southern Resident Killer Whale Distinct Population Segment
Critical Habitat Revision Proposed Rule: 84 Fed. Reg. 49214, September 19, 2019, Endangered and Threatened Wildlife and Plants; Proposed Rulemaking To Revise Critical Habitat for the Southern Resident Killer Whale Distinct Population Segment
Protective Regulations Scoping: 84 Fed. Reg. 57015, October 24, 2019, Scoping Meeting for Protective Regulations for Killer Whales in the Inland Waters of Washington State
Critical Habitat Revision Final Rule: 86 Fed. Reg. 41668, August 2, 2021, Endangered and Threatened Wildlife and Plants; Revision of Critical Habitat for the Southern Resident Killer Whale Distinct Population Segment

1.3.4 Review History

This review is the third 5-year review for Southern Resident killer whales. NMFS completed the first 5-year review in 2011 (NMFS 2011) and the second in 2016 (NMFS 2016a).

1.3.5 Species' Recovery Priority Number at Start of 5-year Review

Southern Resident killer whales have a recovery Priority Number of 1C, based on criteria in the updated Recovery Priority Guidelines (84 Fed. Reg. 18243, April 30, 2019). These guidelines prioritize recovery implementation based on: a) demographic risk; b) recovery potential, which includes how well the threats are known, U.S. jurisdiction over management and protective actions, and certainty that the actions will be effective; and c) the potential for economic conflicts while implementing recovery actions. The Priority Number of 1C for SRKWs reflects a high demographic risk because of rapid population decline, habitat destruction, and continuing threats to recovery. This priority is given to species whose limiting factors and threats are well understood, and when the needed management actions are known (e.g., a recovery plan is in place) and have a high probability of success, but are also in conflict with economic activities.

Implementing regulatory actions for the recovery of the SRKW DPS could involve restrictions on commercial fishing, contaminant discharge, and vessel activities. In 2016, NMFS launched the Species in the Spotlight initiative to highlight conservation actions to aid in the recovery of priority species, including SRKWs. As a part of this program, 5-year Priority Action Plans for 2016-2020 were designed around the existing recovery plans for each species to help guide federal action agencies and provide a more detailed, near-term plan to engage partners to work toward recovery. The program was renewed in 2021. The updated Southern Resident Killer Whale Priority Action Plan for 2021-2025 can be found at https://www.fisheries.noaa.gov/resource/document/species-spotlight-priority-actions-2021-2025-southern-resident-killer-whale.

1.3.6 Recovery Plan or Outline

Name of plan or outline: Recovery Plan for Southern Resident Killer Whales (*Orcinus orca*)
Date issued: January 2008
Dates of previous revisions, if applicable: N/A

2.0 RECOVERY IMPLEMENTATION

Before there was a recovery plan in place for the endangered SRKWs, local, state, federal, and other regional groups were implementing many actions to conserve killer whales and restore a range of habitats, species, and ecosystem processes in the region. In implementing the recovery program over the last decade, NMFS has prioritized actions to address the threats with the highest potential for mitigation: salmon recovery, oil spill response, and vessel impact reduction. Efforts to address additional threats, such as contaminants, have also been implemented. Table 2.1 is from the Recovery Plan (NMFS 2008a) and includes a complete list of potential threats, their associated listing factors, and the potential severity, likelihood, and feasibility of mitigation of the threats. While we have increased our knowledge about these threats and implemented

various recovery actions, the severity and likelihood of the multiple threats affecting recovery remain the same.

Table 2.1. Factors considered in listing decision and likelihood that they affect the recovery of Southern Resident killer whales.

Threat	Listing Factors	Severity	Likelihood	Feasibility of Mitigation
Prey availability	Habitat	High	High	High; many salmon recovery efforts underway
Contaminants	Habitat, Inadequacy of Existing Regulations	High	High	Medium; Puget Sound clean-up efforts underway
Vessel effects (commercial, recreational whale watch)	Habitat, Overutilization, Inadequacy of Existing Regulations	High	High	High; whale watching guidelines and outreach underway, NMFS evaluating regulations and/or protected areas
Vessel effects (other vessel traffic not targeting whales)	Habitat, Inadequacy of Existing Regulations	Medium	High	Medium; safety and security considerations may limit ability to alter shipping lanes, MMPA and ESA mechanisms in place
Sound	Habitat, Inadequacy of Existing Regulations	Medium-High	High	Medium; MMPA and ESA mechanisms in place
Oil spills (pipelines, container and oil tankers)	Other Natural or Human-made Factors	High	Low	High; regulations in place for prevention, response plan for killer whales in development
Oil spills (small chronic sources)	Other Natural or Human-made Factors	Medium	High	Medium; permits and program in place to regulate point and non-point sources
Disease	Disease and Predation	High	Low	Low; opportunistic monitoring in place
Small population size	Other Natural or Human-made Factors	Medium-High	Medium	Low; population monitoring in place
Live-captures for aquaria	Overutilization	Low	Low	Live-captures discontinued, but potential population structure effects remain

Source: Final Recovery Plan for Southern Resident Killer Whales, NMFS 2008a

Examples of efforts to address the primary threats include actions to (1) restore salmon populations on the West Coast that will increase the availability of Chinook salmon prey for

killer whales and (2) restore the degraded nearshore habitats they share. A collaborative and comprehensive effort in Washington State, the Puget Sound Partnership (PSP), also aims to restore the area's ecological health. The PSP considers SRKWs one of its "vital signs" to measure ecosystem health and guide the assessment of progress toward Puget Sound recovery goals (see https://vitalsigns.pugetsoundinfo.wa.gov/VitalSign/Detail/19). NMFS implemented vessel regulations in 2011 to reduce the impacts of vessels and finalized a technical report evaluating their effectiveness in 2017 (Ferrara et al. 2017). The NMFS Species in the Spotlight initiative focuses resources and recovery efforts on priority marine species at risk of extinction, including the SRKW DPS (see Section 1.3.5). Biennial Reports to Congress on Threatened and Endangered Species (2017-2018 and 2019-2020) summarize the actions taken as part of this initiative, and can be viewed here: https://www.fisheries.noaa.gov/resource/document/recovering-threatened-and-endangered-species-report-congress-fy-2017-2018.

In 2018, Governor Jay Inslee signed Executive Order 18-02, which formed a Southern Resident Killer Whale Recovery Task Force to develop long-term recommendations for orca recovery and population sustainability. The Task Force comprised representatives from local, state, federal, and tribal agencies, the private and non-profit sector, and the Government of Canada. From 2018-2019, the Task Force produced two reports containing 49 recommendations for orca recovery with a focus on the major threats: prey availability, vessel impacts, contaminants, emerging climate change issues, and human development. Final reports and information relating to the Task Force can be found at https://www.governor.wa.gov/issues/issues/energy-environment/southern-resident-orca-recovery/task-force.

Efforts to address the various threats to SRKW have forged strong internal partnerships between the West Coast Region and NMFS' science centers. They have also increased collaborations between NMFS and a variety of outside organizations, including the Department of Fisheries and Ocean Canada (DFO), Transport Canada, the Center for Whale Research, the Whale Museum, and the Washington Department of Fish and Wildlife (WDFW).

This Recovery Implementation Section provides a comprehensive summary of agency actions, collaborative efforts, and new knowledge gained over the last five years. Below we have included general information on the costs for the program, listed accomplishments in regulatory programs that support recovery, and identified actions that address the threats to the whales. We have also included updates on actions related to additional sections in the Recovery Plan, such as strandings and transboundary coordination. Actions, progress, and new research results are also discussed in more detail with regard to specific threats criteria and the 5-factor analysis in Sections 3.3 and 3.4.

2.1 Cost

In the Recovery Plan, NMFS identified the many actions already underway, the responsible parties undertaking the actions, and the costs. The implementation table in the Recovery Plan incorporated the actions that had been implemented with funding available in Fiscal Year (FY)2003-FY2007. Costs through FY2010 were provided in the 2011 5-year review, and costs through FY2016 were provided in the 2016 5-year review.

An updated implementation schedule is included in Appendix A of this review and includes the expenditures for management, monitoring, and research actions implemented in FY2017-FY2021. See Figure 2.1 for a summary of costs associated with SRKW research and recovery in the last five years. NMFS' funding represents most of the costs included in the implementation schedule for FY2017-FY2021 (Appendix A and Figure 2.1). Costs from some other sources are listed where available, however they do not contribute to the total costs. The salary costs for NMFS staff working on killer whales are not included, and some costs related to regulatory actions, such as contract support work for the modification to critical habitat, are also not included in Appendix A or Figure 2.1. Cost information for specific high-priority actions for 2021-2025 is listed in the Species in the Spotlight Action Plan. The Recovery Action Database is an online resource to help managers visualize recovery actions and aid in recovery coordination. The Database is used to track recovery implementation for endangered and threatened species in the West Coast Region. It includes all of the actions and projects associated with SRKW recovery, including NMFS funding for individual projects from FY2003-FY2020. The Recovery Action Database can be accessed at https://www.webapps.nwfsc.noaa.gov/apex/f?p=154:1.

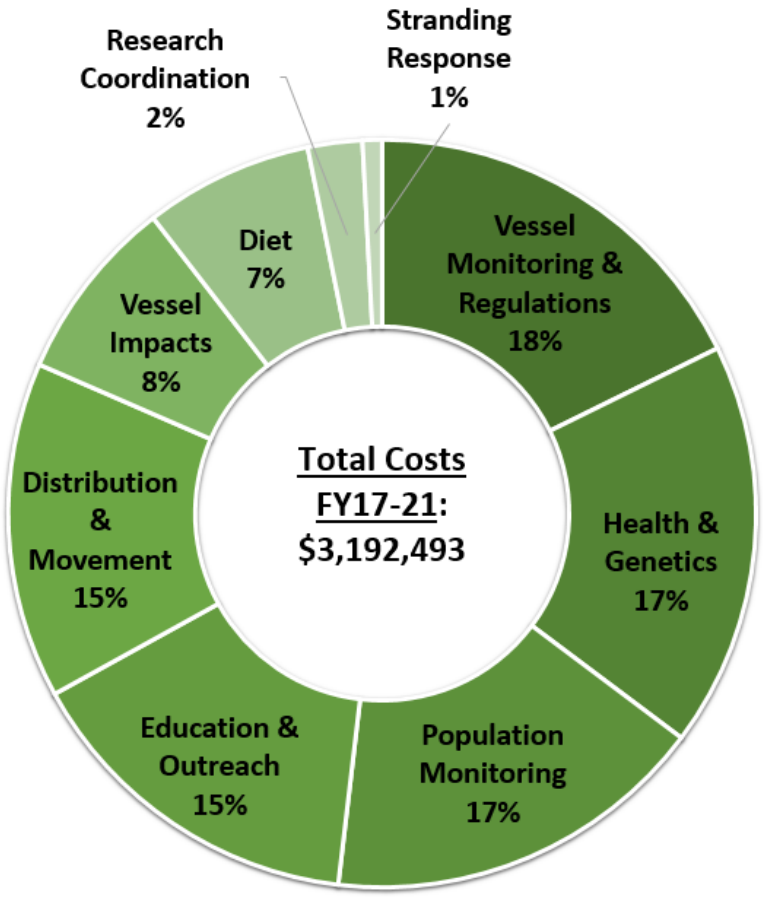


Figure 2.1 Summary of Southern Resident killer whale research and recovery implementation cost categories for FY2017-2021. See Appendix A for an itemized breakdown of the amount by specific task as

outlined in the Recovery Plan. Costs in this total represent NMFS funding and do not include funding from other supporting programs such as NOAA and partner grant programs (e.g. PCSRF, NFWF, Prescott, or Section 6 grants to states for species recovery).

In 2015, the National Fish and Wildlife Foundation (NFWF) created a new grant program to support SRKW recovery efforts. In its first six years, the Killer Whale Research and Conservation Program granted over $4.4 million in funding to projects supporting three key recovery strategies: increasing prey availability, improving habitat quality, and strengthening management through research. These funds were matched by over $8 million in grantee contributions to generate a total of $12.7 million in conservation and research. To recognize this important contribution, NFWF was announced as the Southern Resident Partner in the Spotlight in 2021 (see ESA Bulletin 2019-2020). A 2020 Program Report highlighting the accomplishments of the program can be found at https://www.nfwf.org/sites/default/files/2021-06/NFWF-KWRCF-20210504-2020-report-web.pdf and more information about the Killer Whale Research and Conservation Program can be found at http://www.nfwf.org/killerwhales/Pages/home.aspx.

The Washington State Legislature approved $1.1 billion for implementation of the Governor's Task Force Recommendations in the 2019-2021 Washington State enacted budget. Subdividing into the major threat categories, Washington has allocated $803.6 million towards prey, $143.5 million towards vessels, $186.7 million towards contaminants, and $3.5 million towards science and support. The State approved a budget and will continue to fund Task Force implementation for 2021-2023.

2.2 Biological Opinions

As mandated by the ESA, Section 7, NMFS reviews federal actions to ensure that they do not jeopardize the continued existence of threatened or endangered species, nor adversely modify or destroy their critical habitat. Since SRKWs were listed in 2005, NMFS has evaluated many federal activities that directly affect the whales. For some actions, mitigation has been incorporated into federal activities to reduce or eliminate potential effects to the Southern Residents. NMFS also conducts consultations on the whales' primary prey, Chinook salmon, as some runs are listed as threatened or endangered. NMFS has evaluated several notable activities during the last five years, including the operation and continued presence of the Federal Columbia River Power System, which affects spawning habitat for Chinook salmon (NMFS 2020a); urban development projects in the Puget Sound region (NMFS 2020b); Puget Sound hatchery releases (NMFS 2020c); Klamath Project Operations (NMFS 2019a); California WaterFix Project (NMFS 2017a); and Navy training and testing activities (NMFS 2020d), among others. Most recently, NMFS consulted on the authorization of the Pacific Fishery Management Council (PFMC) West Coast ocean salmon fisheries and a proposed amendment to the Pacific Salmon Fishery Management Plan (NMFS 2021b). The amendment (Amendment 21) limits the fisheries' effects on prey availability for SRKWs by implementing specific management measures (e.g., quota adjustments and spatial/temporal closures) if the Chinook salmon preseason abundance estimate off the Washington coast to Cape Falcon, OR, drops below an established low abundance threshold (86 Fed. Reg. 29544, June 2,

2021). NMFS approved Amendment 21 on August 31, 2021 (86 Fed. Reg. 51017, September 14, 2021).

2.3 Addressing Key Threats

Along with many partners, NMFS has been engaging in research and management actions to better understand and address the key threats to the whales. Below are some general descriptions of NMFS activities over the last five years. Additional details, including efforts by many of our partners, are included in more detail in Section 2.6.

Prey
The West Coast community has been engaged in salmon recovery for many years. For specific information on salmon recovery efforts, please visit www.salmonrecovery.gov and https://www.fisheries.noaa.gov/species/pacific-salmon-and-steelhead. The Pacific Coastal Salmon Recovery Fund (PCSRF) provides funding for many of these efforts. The PCSRF was established by Congress in 2000 to protect, restore, and conserve Pacific salmon and steelhead populations and their habitats. Under the PCSRF, NMFS manages a program to provide funding to states and tribes of the Pacific Coast region (Washington, Oregon, California, Nevada, Idaho, and Alaska). In recent years, the priorities for PCSRF have been updated to include a specific focus on Species in the Spotlight, including both ESA-listed salmon and SRKWs. The thousands of PCSRF projects implemented throughout the region have made significant contributions to improve the status of ESA-listed populations of salmonids (or Evolutionarily Significant Units, ESUs), prevent extinctions, protect currently healthy populations, and support the prey base for SRKWs. These accomplishments are summarized in independent reviews and annual Reports to Congress, which can be found on our web page at https://www.fisheries.noaa.gov/grant/pacific-coastal-salmon-recovery-fund.

In addition to PCSRF initiatives, NMFS is engaged in many other habitat restoration and mitigation efforts that improve or offset impacts to the primary SRKW prey base, Chinook salmon. For example, a "conservation calculator" based on a Habitat Equivalency Model has been adapted for Puget Sound nearshore habitat (critical for juvenile salmon survival) to help developers and other entities conducting work on structures in the nearshore environment calculate the habitat impacts, or debits, and habitat improvements, or credits, of their projects. When debits are offset with an equivalent number of credits, the result is no net loss of nearshore habitat. In 2020 and 2021 biological opinions that determined jeopardy for Puget Sound Chinook and SRKW, and adverse modification of their critical habitat, for 39 and 11 nearshore development projects by the U.S. Army Corps of Engineers, respectively, NMFS used the calculator to assess the long-term impact of each project. The Reasonable and Prudent Alternative in each opinion laid out a variety of mitigation options for each of the projects and required that all debits be offset by an equal amount of credits, resulting in no net loss of habitat (NMFS 2020b, 2021d). More information on the conservation calculator can be found at https://www.fisheries.noaa.gov/west-coast/habitat-conservation/puget-sound-nearshore-habitat-conservation-calculator.

While the conservation calculator takes a "no net loss" approach, NMFS also engages in active improvements and restoration of habitat critical to salmon survival at all life stages. During the last five years, the NOAA Restoration Center (RC) has contributed $7.5 million in funding through its Community-based Restoration Program to restore habitat for Chinook salmon. In addition, NOAA RC supported numerous habitat restoration projects in Puget Sound through its Damage Assessment, Remediation, and Restoration Program (DARRP) that restored Chinook salmon habitat. More details on all restoration projects can be found at https://www.fisheries.noaa.gov/resource/map/restoration-atlas. NMFS West Coast Region (WCR) convenes bimonthly internal, cross-divisional calls to coordinate SRKW prey-related recovery efforts, including habitat, hatcheries, harvest, and hydropower-related projects. Staff and leadership from regional and area offices regularly share updates and priorities to align SRKW initiatives across the region.

NMFS regularly monitors progress on salmon recovery by conducting 5-year reviews for 28 listed ESUs and DPSs of Pacific salmon and steelhead (84 Fed. Reg. 53117, October 4, 2019). The 2021 5-year reviews are being finalized. For information on the previous 5-year reviews for salmon and steelhead conducted in 2016, please visit https://www.fisheries.noaa.gov/action/2016-5-year-reviews-28-listed-species-pacific-salmon-steelhead-and-eulachon.

In the last five years, NMFS has coordinated and participated in several working groups focused on addressing prey availability and recovery for SRKWs. In 2018, NMFS and WDFW, with input from tribal organizations, NGOs, and DFO, completed an assessment of priority Chinook salmon stocks for SRKW to inform salmon management and conservation actions to increase the SRKW prey base. In 2019, the PFMC convened the Ad Hoc Southern Resident Killer Whale Workgroup (Workgroup) with NMFS, the U.S. Coast Guard, and state and tribal partners to reassess the effects of the PFMC-area (coast of Washington, Oregon, and California) ocean salmon fisheries on SRKW. Section 3.3.2 provides a detailed description of the findings from these reports.

Salmon fisheries off Alaska, Canada, Washington, and Oregon are managed under the Pacific Salmon Treaty (PST). In 2018, Canada and the United States reached a new 10-year agreement under the terms of the PST. This agreement includes harvest reductions for Chinook fisheries in both countries that will help protect a variety of stocks that are important to the whales while providing sustainable harvest opportunities for First Nations, Indian Tribes, and commercial and recreational fishers. These harvest reductions will increase the annual salmon abundance returning to the southerly U.S. Pacific Coast Region than under previous PST Agreements. Overall, fishery impacts on Chinook have been reduced coastwide over the past decade, including areas where SRKWs are more likely to occur. The fishery management frameworks used to manage all of these fisheries reduce, to some degree, allowable catch levels in years of low Chinook abundance.

In addition to fishery reductions, the new PST agreement includes a funding initiative. This funding initiative is designed to produce hatchery fish to conserve Puget Sound Chinook critical populations, increase hatchery production of Chinook to provide

additional prey for Southern Residents, and restore habitat for Puget Sound Chinook populations. The funding initiative has a goal of a 4-5% increase in available prey throughout inland waters in the summer and coastal waters in the winter, which are frequented by the whales and affected by fisheries managed under the PST, with increased abundance in these regions beginning to accrue in 3-5 years following implementation. Funds were received in both FY20 and FY21 to support hatchery production. WDFW is also dedicating resources and contributing toward the goal of producing additional Chinook as prey for Southern Residents.

In addition to increased hatchery production, the PST-related funding initiative has funded projects to improve habitat conditions for specified populations of Puget Sound Chinook salmon, which we anticipate would increase Puget Sound Chinook salmon abundance, also benefiting SRKWs. The FY20-21 appropriated funds for implementation of U.S. domestic actions associated with the new PST Agreement included $10.4 million in support of this habitat restoration effort. By improving conditions for these populations, we anticipate salmon abundance in Puget Sound watersheds, including Chinook salmon, would increase, potentially benefiting SRKWs.

Contaminants

To address the threat of pollution and contamination, NMFS has worked with the PSP, who is leading the cleanup of Puget Sound to restore and protect the ecosystem. PSP regularly releases an Action Agenda with a list of Near Term Actions that integrate scientific assessment with community priorities, and establish a unified set of actions to protect and restore Puget Sound. NMFS is the lead for reporting on the status of SRKWs, which are listed as Vital Signs of ecosystem health in the Action Agendas. In 2016 and 2018, the number of SRKWs was identified as an indicator of Puget Sound's health. As such, their recovery fell under the six recovery goals for all of Puget Sound (PSP 2016, 2018). The 2020 target of 95 whales was not met, and the SRKW population trend is one of five indicators that have worsened relative to the baseline condition. The PSP works with various partners, including NGOs, state and federal agencies and tribes, to accomplish these goals, and each year they publish their *State of the Sound* to inform the public and decision makers of the progress that has been made. For more information on the PSP's efforts to address pollution and contaminants, please visit http://www.psp.wa.gov/.

Most pollution and contamination management efforts have focused on reducing persistent organic pollutants (POPs). SRKWs have some of the highest levels of these chemicals compared to other marine organism (Alonso et al. 2014). In 2016, NMFS released a comprehensive Technical Memorandum that reviews the contaminants that may pose a risk to the SRKWs and discusses the health implications of exposure to these contaminants (Mongillo et al. 2016). The report focuses on three POPs of concern: polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and dichlorodiphenyltrichloroethane (DDT) and its metabolites. These POPs are of particular concern because they are found at relatively high levels in the whales compared to other resident killer whales in the North Pacific (Ross et al. 2000; Krahn et al. 2007; Krahn et

al. 2009; Alonso et al. 2014; Alava et al. 2016; Lawson et al. 2020) and may cause adverse health effects.

Health

Understanding how environmental and human-caused factors influence the health of SRKWs is crucial to identifying the threats faced by the species and the actions needed to aid in their recovery. In 2017, the SeaDoc Society commissioned an independent science panel to identify evidence for poor body condition in SRKWs, recognizing the multitude of factors that can lead to declining body condition, and the need for individual-level analysis. The lines of evidence identified to evaluate SRKW body condition included sighting data (photo ID), photogrammetry, mortality data (e.g., from stranded carcasses), social dynamics, and fecal hormones.

In the last five years, there have been significant research advancements utilizing photogrammetry techniques to generate body condition indices on individual killer whales (Fearnbach et al. 2018, 2019; Stewart et al. 2021). These data help to inform in near-real-time the health and reproductive status of individuals and the population as a whole, compare body condition across years, and potentially identify correlations with environmental conditions (e.g., prey availability).

In addition to environmental threats, such as lack of prey or contaminants, the small size of the SRKW population may lead to poor health through inbreeding. Matings between close relatives have been documented in the population (Ford et al. 2018), indicating that inbreeding depression may be limiting population growth. To further evaluate the effects of inbreeding, NMFS, The Nature Conservancy, and BGI, a leader in genomics research, embarked on a new partnership in 2018 to sequence the full genomes of 101 killer whales. These data are currently being analyzed, and are providing new information on levels of inbreeding in SRKWs compared to other killer whale populations and the degree to which this inbreeding is harming the population's prospects for recovery.

NMFS has compiled data from multiple projects into a health database at its NWFSC and has also worked with partners at UC Davis and the Marine Mammal Foundation to bring additional data into a single database to help look for patterns from individual health profiles. NMFS and its partners are collaborating to utilize non-invasive samples for bacterial microbiome analyses as potential health assessment methods.

Vessel Effects

NMFS coordinates with the U.S. Coast Guard, WDFW, Transport Canada, and DFO to evaluate the need for regulations and identify areas for vessel restrictions as described in the Recovery Plan. Recent actions by Washington State and the Government of Canada have expanded current distance and speed regulations for vessels to reduce impact to the whales. These include both voluntary guidelines and mandatory regulations. NMFS continues to work with state and Canadian partners to incorporate new information on federal, state, and Canadian regulations, and ensure all of the latest information is available at www.bewhalewise.org. For a summary of the regulatory history related to vessel impacts to the whales, see Section 3.3.2, A4 of the delisting criteria. In 2017,

NMFS published a Technical Memo (Ferrara et al. 2017) that evaluated the effectiveness of the U.S. Federal regulations since 2011. For a description of the findings, see Section 3.4.2, D2 of the downlisting criteria.

In 2019, NMFS conducted a scoping meeting and public comment period to gather input on whether existing regulations and other measures adequately protect killer whales from the impacts of vessels and noise in the inland waters of Washington State and, if not, what actions NMFS should take (84 Fed. Reg. 57015, October 24, 2019). NMFS is scoping potential updates to federal regulations that would better align the regulations with recent changes in Washington State and Canadian regulations and the needs of the whales.

In 2021, Washington implemented a Commercial Whale Watch Licensing Program (CWWLP), which requires commercial operators to maintain a commercial whale watching license to view SRKWs. NMFS participated on an independent scientific panel through the Washington Academy of Sciences and on an intergovernmental working group to share research results and experience with the federal regulations and inform the state process to develop the CWWLP. For a description of the new commercial whale watching license program see Section 3.3.2, B1 of the delisting criteria.

NMFS has participated in a partnership led by the Port of Vancouver called the Enhancing Cetacean Habitat and Observation (ECHO) Program, which launched in 2014 (for a description of the program, see Section 2.6). The Southern Resident Orca Task Force recommended creating a program similar to ECHO in the U.S, and NMFS participated in developing this new initiative, Quiet Sound, which aims to study and reduce the impacts of acoustic and physical disturbance from large commercial vessels on SRKWs. For more information on Quiet Sound, please visit https://maritimeblue.org/quiet-sound/. While Quiet Sound was in development, NMFS also worked with partners to continue to make progress on specific projects, like the broader application of the Canadian Whale Report Alert System (WRAS) in U.S. waters. This system broadcasts details of whale presence to large commercial ships to enable vessels to undertake adaptive mitigation measures, such as slowing down or altering course in the presence of cetaceans, to reduce the risk of collision and disturbance.

Oil Spill Threat

NMFS has worked closely with partners to address the threat of an oil spill in killer whale habitat by developing a killer whale-specific oil spill response plan, which has been incorporated into the Northwest Area Contingency Plan (NWACP) (https://www.rrt10nwac.com/nwacp/), as well as a hazing implementation plan to deter killer whales from entering spilled oil (https://media.fisheries.noaa.gov/dam-migration/srkw_oilspill_hazing-imp-plan_2014update.pdf). NMFS participates with WDFW, the Washington Department of Ecology, and other partners in annual drills to practice implementation of the response plans, including deterrence methods. NMFS also continues to work with partners to gather more information on the available deterrence methods, such as recording the sounds from helicopters and banging pipes, to evaluate the most effective distances and deployments.

The Washington Department of Ecology hosted a marine mammal management workshop for oil spill responders in September 2021. NMFS participated in workshop planning and presented the killer whale hazing implementation plan and other relevant information on marine mammal response guidance and authorizations. Over 300 wildlife responders, oil and gas industry members, stranding partners, resource managers, and others participated in the workshop. A recording of the workshop and other oil spill response resources can be found at https://www.oilspills101.wa.gov/.

More information on NMFS' efforts to minimize the threat of oil spills to killer whales can be found at https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/southern-resident-killer-whale-recovery-planning-and#oil-spills.

2.4 Outreach Partners

NMFS works closely with museums and aquariums, non-profit groups, researchers, and schools to raise awareness and educate the public about the recovery of SRKWs and how individuals and organizations can contribute to conservation. A few examples of our partnerships and education and outreach programs include:

- The Seattle Aquarium operates an Orca Family Center to inspire conservation of our marine environment (www.seattleaquarium.org).
- The Whale Museum features conservation messages in its educational programs, exhibits, and the Soundwatch Boater Education Program (www.whalemuseum.org).
- Killer Whale Tales promotes classroom understanding and stewardship (www.killerwhaletales.org).
- The Orca Network connects whales and people in the Pacific Northwest and collects sighting information (www.orcanetwork.org).
- The Whale Trail inspires appreciation and stewardship of whales and our marine environment by establishing a network of land-based viewing sites (www.thewhaletrail.org).
- Whale Scout protects Pacific Northwest whales through land-based conservation experiences. (https://www.whalescout.org/).
- NMFS' middle school-level project-based learning unit on Southern Resident promotes science and stewardship. This new curriculum began in 2021and complements previous high school level materials. (https://www.fisheries.noaa.gov/resource/educational-materials/saving-southern-resident-killer-whales). (https://archive.fisheries.noaa.gov/wcr/publications/education/kwrecoveryunitall.pdf) Both curriculums align with state learning requirements.
- A new education partnership formed in 2021 provides additional training. The National Marine Mammal Foundation will lead an educational workshop for K-12 students in Southern California that focuses on Southern Residents, and its Youth Action Council for older students will lead public awareness initiatives.

2.5 Strandings and Emergency Response

Stranded killer whales provide valuable opportunities for us to learn about the status and threats to the population. In addition, NMFS has led emergency response actions for individual whales identified as an "animal of concern" that meet the emergency response criteria. As part of NMFS' role in coordinating the West Coast Marine Mammal Stranding Network, we work with network members to prepare for and respond to live or dead stranded killer whales. We also coordinate with other regions to assist with stranding response. We developed an initial stranding protocol for killer whales for the network. Partners from the U.S. and Canada have also developed a detailed Killer Whale Necropsy and Disease Testing Protocol, which was updated in 2014. In partnership with UC Davis, NMFS has provided funding to ensure prompt and thorough examinations are conducted on any stranded killer whale carcass. Stranding response along the West Coast has also been supported through the John H. Prescott Marine Mammal Rescue Assistance Grant Program. An updated analysis of killer whale strandings along the West Coast was recently published and includes a comprehensive synthesis of pathology results and correlations with body condition (Raverty et al. 2020).

There were three SRKW strandings that could be necropsied in the last five years. The data collected has increased our knowledge about the population's health and the impacts of their health-related threats. Transboundary partnerships have supported thorough necropsies of a female neonate, L95, and J34, all in 2016, including testing for contaminant loads, disease and pathogens, organ condition, signs for human interactions, and diet composition. The female neonate and J34 died from trauma, while L95 died from an invasive fungal infection. Reports are available at https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/southern-resident-killer-whale-recovery-planning-and#strandings or see Raverty et al. (2020) Table 2 for information on the female neonate. A final necropsy report for J34, who was found dead near Sechelt, British Columbia on December 20, 2016 can be found at: https://www.pac.dfo-mpo.gc.ca/fm-gp/mammals-mammiferes/whales-baleines/j34-eng.html. Except for the observation of J35's calf that died (see below) and was not recovered, there were no SRKW strandings reported in 2017-2021 in Washington, Oregon, California, or British Columbia.

In 2018, emergency response efforts were conducted to aid and monitor two members of the SRKW population: J50 and J35. J50, also known as Scarlet, was a 3-year old female in poor body condition and J35, also known as Tahlequah, carried her dead calf for approximately 17 days after it died shortly after birth (Shedd et al. 2020). Detailed information regarding the response efforts and a timeline of the events can be found on our website at https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/southern-resident-killer-whale-recovery-j50-and-j35.

NMFS' developed Guidance for SRKW Emergency Response, which: (1) outlines NMFS' goals and principles, and (2) identifies indicators and considerations to inform decision-making for emergency response, including if and when to intervene, as well as circumstances that would lead to a decision not to intervene. While we cannot outline every possible scenario or outcome, this guidance considers circumstances for emergency response, reviews options, and assists in preparing for and implementing any emergency

response for individual SRKWs. The SRKW emergency response guidance and additional supplemental materials regarding options, tools, and techniques for emergency response reflect valuable input from NMFS' partners and the broad community interested in SRKW recovery.

2.6 Recovery Coordination

NMFS continues to coordinate with federal, state, and international agencies regarding killer whale recovery programs. Starting with an Executive Order in 2018 for the creation of a Southern Resident Orca Task Force, Washington State initiated a new effort to mobilize state authorities and resources and became a critical partner in the recovery of SRKW. NMFS has worked closely with Washington State, and was a member of the Task Force, which included nearly 50 members representing a wide range of sectors from state agencies; the state legislature; tribal, federal, and local governments; the whale watching industry; and nonprofit organizations to provide expertise and a range of perspectives. NMFS also participated in the individual threat-based working groups to provide our latest research, technical expertise, and experience from over a decade of implementing our ESA Recovery Plan for SRKWs. The Task Force also heard from many members of the public who attended the six Task Force meetings and provided thousands of comments. The final report from the Governor's Task Force in 2019 summarized progress on 36 recommendations related to SRKW recovery from the 2018 Task Force report and outlined 13 additional recommendations, outstanding needs and lessons learned. The Washington State Legislature provided approximately $13 million in funding "prioritized to increase prey abundance for southern resident orcas" (ESHB 1109) for the 2019-2021 biennium. As a result of this additional funding, over 10.8 million additional hatchery-origin Chinook salmon were released in 2020 to augment the SRKW prey base, and over 10.1 million additional hatchery-origin Chinook salmon are expected to be released in 2021. Further, another 8 million chum salmon and 5 million coho are being produced. The released smolts would return as adults and be part of the SRKW prey base three to five years later.

In addition, Washington State passed HB 1579 that addresses habitat protection of shorelines and waterways. The bill also provides funding for salmon habitat restoration programs, and boosts technical assistance and enforcement of state water quality, water quantity, and habitat protection laws. Other recent actions include measures to increase survival through the hydropower system on the lower Snake and Lower Columbia rivers, legislation to decrease impacts of predatory fish on salmon, funding to the Washington State Department of Transportation to complete fish barrier corrections, and funding to implement a lower Snake River dams stakeholder engagement process. These measures are designed to improve prey conditions in the long term.

One of the primary vectors of PBDE contamination in Puget Sound is through the discharge of treated wastewater. The Governor's Task Force focused one recommendation in the 2018 report on mitigating stormwater risks and accelerating cleanup efforts, which were identified as urgent actions. The Task Force listed additional recommendations in the final 2019 report that focused on reducing SRKW exposure to

contaminants. Recent research on POPs and other contaminants in Southern Residents is discussed in Sections 3.3.2 and 3.4.2.

The Governor's Task Force listed one recommendation (#24) to reduce the threat of oil spills to the survival of SRKWs in Puget Sound. The Washington State legislature adopted this recommendation in part by amending RCW 88.16.190 to require oil tankers of greater than 125,000 deadweight tons to be escorted by tugs in inland waters. Task Force recommendations were implemented by Ecology and the Washington Board of Pilotage Commissioners. Other actions include a curriculum plan for a killer whale deterrence program (https://apps.ecology.wa.gov/publications/SummaryPages/1808006.html) and support for stationed emergency response towing vessels.

A new initiative coming out of a recommendation from the Task Force (#22) is a U.S.-based program known as Quiet Sound, similar to the Canadian ECHO program (described below). The Quiet Sound program (see Section 2.3) is a highly coordinated effort among many partners; federal partners include the U.S. Coast Guard (USCG), which participated on the planning committee, and the Environmental Protection Agency (EPA), which provided funding support. In addition, NMFS coordinates with USCG on their SRKW efforts, including the promotion of Be Whale Wise (see https://content.govdelivery.com/accounts/USDHSCG/bulletins/2e37e84).

Additional efforts in Washington State include the PSP goals that link to SRKW, one of the PSP vital signs. In 2021, the PSP released a list of their Desired Recovery Outcomes for the forthcoming 2022 Action Agenda, which includes protecting wild salmon genetic diversity to improve prey availability for killer whales, and reducing vessel interference with killer whale behavior. More information on the Action Agenda can be found at https://www.psp.wa.gov/action_agenda_center.php, and a new tool is now available to track the progress of PSP Action Agenda projects: https://www.pugetsoundinfo.wa.gov/.

NMFS also works across the border with Canada to coordinate recovery initiatives. NMFS and DFO conduct regular meetings regarding killer whale recovery to share information, provide updates on recovery actions including education, outreach, and enforcement considerations, and ensure consistency on both sides of the border whenever possible. Under the Canadian *Species at Risk Act,* the SRKW and Northern Resident Killer Whale (NRKW) are listed as Endangered and Threatened, respectively. DFO developed a Recovery Strategy for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada (published in 2008 and amended in 2011 and 2018) and supporting Action Plan (2017) to identify key threats to NRKW and SRKW recovery and set out measures and actions to address them. These measures were developed to support recovery and to address the three primary threats to the population – physical and acoustic disturbance, prey availability, and contamination. The Recovery Strategy also identifies critical habitat for both populations with SRKW critical habitat in the transboundary waters in southern British Columbia, including the southern Strait of Georgia, Haro Strait and Juan de Fuca Strait, and was amended in 2018 for both NRKW and SRKW to include the southwest coast of Vancouver Island, including Swiftsure and

La Pérouse Banks. Annual transboundary enforcement meetings between DFO, NOAA Office of Law Enforcement, and WDFW have taken place to share, discuss and collaborate on implemented and proposed SRKW enhanced management measures operational needs, enforceability requirements and outreach strategies.

The Marine Mammal Research Unit at the University of British Columbia hosted a technical workshop on the Availability of Prey for Southern Resident Killer Whales in November 2017. This workshop assembled scientists and managers with technical expertise on killer whales and Chinook salmon to identify and evaluate short-term management actions that might increase the immediate abundance and accessibility of Chinook salmon for SRKW. Output from this workshop helped inform fisheries management measures taken by DFO for 2018 in support of threat abatement and recovery of SRKW. Priority management actions identified in the workshop included 1) increasing abundance of Chinook in specific areas and times by adjusting removals by fisheries and 2) increasing accessibility of Chinook by decreasing underwater noise and physical disturbances by vessel presence in key SRKW foraging areas. While reducing coast-wide fishery removals was discussed as an additional management option, there was generally less support with this approach from workshop participants given weak scientific justification and confidence, which was consistent with the findings of the previous transboundary panel (i.e. Hilborn et al. 2012) (Trites and Rosen 2018).

Since 2018, the Government of Canada, with input from the Indigenous and Multi-Stakeholder Advisory Group, Technical Working Groups and consultation with Indigenous groups and stakeholders, has implemented a number of enhanced management measures aimed at increasing prey availability for SRKWs—particularly Chinook salmon—and reducing threats related to physical and acoustic disturbance with a focus in key foraging areas within SRKW critical habitat. These measures include salmon fishery closures, Interim Sanctuary Zones that restrict vessels including fishing from entering (with some exceptions), minimum vessel approach distances and a number of voluntary measures in the presence of killer whales to reduce disturbance and prey competition. New for 2021, DFO piloted a fishing closure protocol for the southern Gulf Islands recreational and commercial salmon fisheries, where fishery closures are triggered by the first confirmed presence of SRKWs in the area. The *Marine Mammal Regulations* remain in effect year-round, and require maintaining a minimum 200 meter approach distance from all killer whales in Canadian Pacific waters other than those described above, and, 100 meters for other whales, porpoises and dolphins or 200 meters when the animal is in resting position or with a calf.

The Government of Canada is addressing the threat of contaminants by strengthening regulations and developing guidelines, increasing research and monitoring, encouraging data sharing, and expanding outreach and education initiatives. More details on the 2021 management measures can be found at https://www.canada.ca/southern-resident-killer-whales.

The Government of Canada has also developed a Southern Resident Killer Whale Accountability Framework to help understand if short- and longer-term management

measures are supporting the recovery of SRKWs. Within this Framework, proxy indicators and performance measures are identified for three priority action categories to enable consistent reviews of performance data and the addition or modification of indicators and measures over time. Further information, including access to the report can be found at https://www.pac.dfo-mpo.gc.ca/fm-gp/mammals-mammiferes/whales-baleines/docs/srkw-framework-cadre-ers-2021-eng.html.

In 2020, the Canadian Coast Guard implemented a Marine Mammal Desk, which reports whale sightings in near real time to enforcement agencies and assists vessel traffic management by providing enhanced situational awareness of the activities of SRKWs and other cetaceans. The desk is staffed 24 hours a day, seven days a week and utilizes radar and Automatic Identification Systems (AIS) and real-time vessel movement information to support partners like Transport Canada by monitoring SRKW Interim Sanctuary Zones. The news release can be found at https://www.canada.ca/en/canadian-coast-guard/news/2021/01/canadian-coast-guard-opens-the-first-marine-mammal-desk-to-better-protect-southern-resident-killer-whales-and-other-cetaceans.html.

The BC Marine Mammal Response Network (BCMMRN) is comprised of non-governmental organizations, Government of BC, led by Fisheries and Oceans Canada and coordinates with US counterparts. The BCMMRN responds to marine mammal incidents, including injured, stranded, entangled or dead animals. The network maintains a database of incidents, including SRKW incidents.

NMFS actively participates in the ECHO program, a partnership led by the Vancouver Fraser Port Authority. Recognizing that commercial marine activity in the region is increasing, and has the potential to impact at-risk whales, the Vancouver Fraser Port Authority launched the ECHO Program in 2014 to better understand and reduce the cumulative effects of shipping on whales throughout the southern coast of British Columbia. The Port Authority works with a diverse range of partners and advisors, including government agencies, the marine transportation industry, Indigenous communities, environmental groups, and scientists. The long-term goal of the ECHO Program is to develop and implement initiatives that result in a quantifiable reduction in threats to whales as a result of shipping activities. NMFS has participated in both the Advisory Working Group and Technical Work Groups for ECHO. In the last five years, the ECHO program has implemented multiple voluntary slow-down trials to reduce the noise generated by large commercial vessels in areas such as Haro Strait, Boundary Pass, and starting in 2020, Swiftsure Bank. The ECHO program has experienced a high participation rate with these voluntary measures. More information about the ECHO Program can be found at https://www.portvancouver.com/echo and the latest Annual Report for 2020 can be found at https://www.portvancouver.com/wp-content/uploads/2021/04/2021-04-05-ECHO-2020-Annual-report_Final-1.pdf.

3.0 REVIEW ANALYSIS

3.1 Application of the 1996 Distinct Population Segment (DPS) Policy

3.1.1 Is the Species under Review a Vertebrate?

__X_ ***Yes****, go to section 3.1.2.*
_____***No****, go to section 3.2.*

3.1.2 Is the Species under Review Listed as a DPS?

_X__ ***Yes****, go to section 3.1.3.*
____ ***No****, go to section 3.1.4*

3.1.3 Was the DPS Listed prior to 1996?

____ ***Yes****, give date and go to section 3.1.3.1.*
_X__ ***No****, go to section 3.1.4.*

3.1.3.1 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

____ ***Yes,*** *provide citation and go to section 3.1.4.*
____ ***No****, go to section 3.1.3.2.*

3.1.3.2 Does the DPS listing meet the discreteness and significance elements of the 1996 DPS policy?

____ ***Yes****, discuss how it meets the DPS policy, and go to section 3.1.4.*
____ ***No****, discuss how it is not consistent with the DPS policy and consider the 5-year review completed. Go to section 3.5.2, Synthesis.*

3.1.4 Is there Relevant New Information for this Species Regarding the Application of the DPS Policy?

____ ***Yes****, provide citation(s) and a brief summary of the new information; explain how this new information affects our understanding of the species and/or the need to list as DPSs. This may be reflected in section 4.0, Recommendations for Future Actions. If the DPS listing remains valid, go to section 3.2, Recovery Criteria. If the new information indicates the DPS listing is no longer valid, consider the 5-year review completed, and go to section 3.5.2, Synthesis.*
__X__ ***No****, go to section 3.2., Recovery Criteria.*

3.2 Recovery Criteria

3.2.1 Does the Species have a Final, Approved Recovery Plan[1] Containing Objective, Measurable Criteria?

_X__ ***Yes****, continue to section 3.2.2.*

____ ***No****, consider recommending development of a recovery plan or recovery criteria in section IV, Recommendations for Future Actions, and go to section 3.4.1, Updated Information and Current Species Status.*

3.2.2 Adequacy of Recovery Criteria.

3.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?

_X__ ***Yes,*** *go to section 3.2.2.2.*
____ ***No****, go to section 3.2.3, and note why these criteria do not reflect the best available information. Consider developing recommendations for revising recovery criteria in section 4.0.*

In April 2021, NMFS released the announcement of this impending review in the Federal Register and solicited comments, including input on the adequacy of the recovery criteria (86 Fed. Reg. 21282, April 22, 2021). The comment period closed on June 21, 2021 and 30 comments were received, two of which commented on the need to update the Southern Resident Recovery Plan and recovery criteria, and one that commented on the inadequacy of the existing recovery criteria. As such, NMFS will continue to evaluate the criteria moving forward and seek input before making any revisions.

3.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? *(Note: If it can be clearly articulated how recovery criteria address all current threats to the species, evaluating whether recovery and/or downlisting criteria have been met in section 3.2.3 may be sufficient to evaluate the species listing classification and no further analysis may be necessary.)*

_X__ ***Yes****, go to section 3.2.3.*
____ ***No****, go to section 3.2.3, and note which factors do not have corresponding criteria. Consider developing recommendations for revising recovery criteria in section 4.0.*

[1]Although the guidance generally directs the reviewer to consider criteria from final approved recovery plans, criteria in published draft recovery plans may be considered at the reviewer's discretion.

3.2.3 List the Recovery Criteria as they Appear in the Recovery Plan, and Discuss how each Criterion has or has not been Met, Citing Information.

(for threats-related recovery criteria, please note which of the 5 listing factors are addressed by that criterion. If any of the 5-listing factors are not relevant to this species, please note that here):

If you answered *yes* to both 3.2.2.1. and 3.2.2.2., evaluating whether recovery and/or downlisting criteria have been met in section 2.2.3 may be sufficient to evaluate the species listing classification and no further analysis may be necessary; *go to section 3.5.2, Synthesis.*

3.3 Delisting Criteria

3.3.1 Biological Criteria

To remove the Southern Resident killer whale DPS from the Federal List of Endangered and Threatened Wildlife and Plants under the ESA, NMFS must determine that the species is neither in danger of extinction nor likely to become so "in the foreseeable future throughout all or a significant portion of its range."

Criteria:
1. The Southern Resident DPS has exhibited an increasing population trend at an average growth rate of 2.3 percent per year for 28 years (two full cycles).

2. Available information on social structure, calf recruitment, survival, population age structure, and gender ratios of the Southern Resident DPS are consistent with the trend observed under Criterion 1 above and are indicative of an increasing or stable population.

Quantitative measures for population parameters include:
- Representation from at least three pods,
- More than two reproductive age males in each pod or information that fewer males are sufficient,
- A ratio of juveniles, adults, post-reproductive, male and female individuals similar to the Northern Resident population model [i.e., 47 percent juveniles, 24 percent reproductive females, 11 percent post-reproductive females, and 18 percent adult males] (Olesiuk et al. 2005),
- Adequate inter-birth intervals to allow for population growth,
- No significant increase in mortality rate for any sex or age class.

Have the Biological Criteria for Delisting been met?
No, not all of the biological delisting criteria have been met.

1. Over the last 28 years, the SRKW population size has fluctuated and there has not been an average increase per year for the population (Figure 3.1) (Caretta et al. 2021). In 2020 there were 72 whales counted in the summer census (conducted annually by the Center for Whale Research). At the time of the 2021 census, there were 74 whales counted in the population, with three calves born between the 2020 and 2021 censuses, and all three surviving at the time of this

report (CWR 2021). Since the latest census, one additional whale is presumed dead: K21, an adult male.

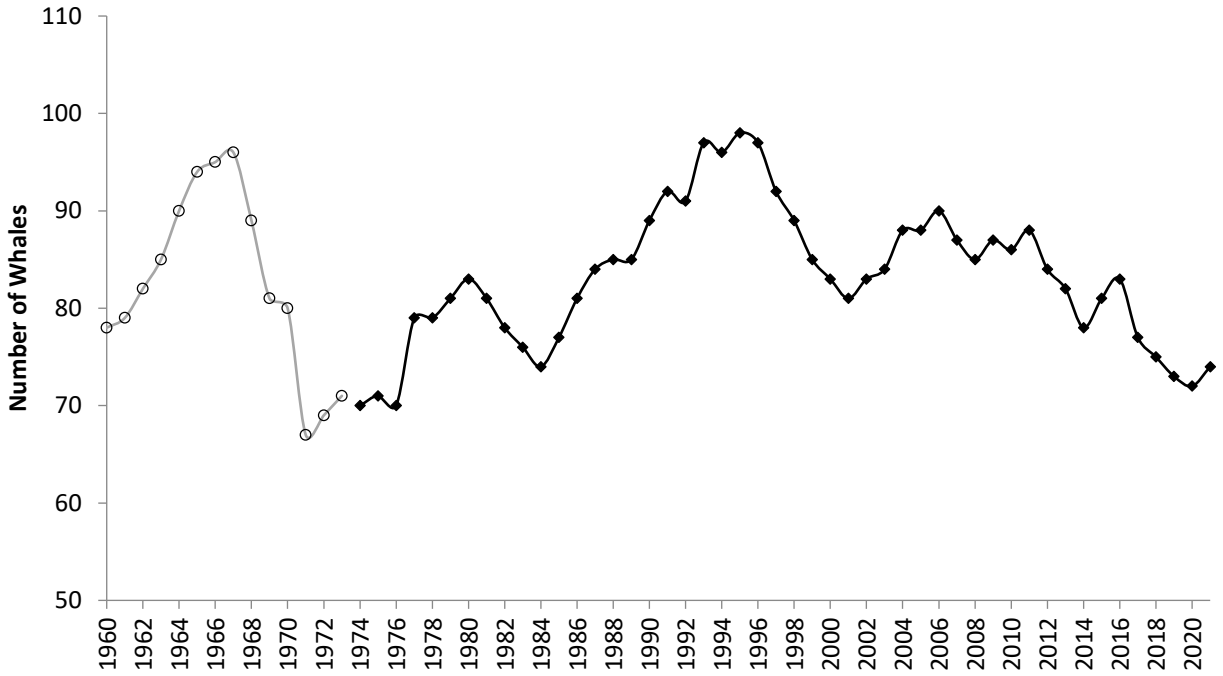


Figure 3.1 Population size and trend of Southern Resident killer whales, 1960-2021. Data from 1960-1973 (open circles, gray line) are number projections from the matrix model of Olesiuk et al. (1990). Data from 1974-2021 (diamonds, black line) were obtained through photo-identification surveys of the three pods (J, K, and L) in this community and were provided by the Center for Whale Research (unpublished data) and NMFS (2008a). Data for these years represent the number of whales present at the end of each calendar year, or after the summer census for 2012 onwards.

2. There is representation in all three pods, J (24 whales), K (16 whales), and L (33 whales) in the SRKW population. Of the 73 individuals in the population, 26 are reproductive-age males and 28 are reproductive-age females. At the time of this review, 6 reproductively mature males (age 10 and older) were in J pod, 8 in K pod, and 12 in L pod. However, based on a recent study that built a population pedigree using genetic data from 105 individuals, 52% of the offspring born between 1990 and 2015 were sired by two fathers, meaning that less than 30 individuals made up the effective reproducing portion of the population during that time (Ford et al. 2018). In addition, there were four highly inbred offspring in the population pedigree, raising questions about the fitness effects of inbreeding (Ford et al. 2018). Recent and ongoing research into the relationship between genetic diversity, effective breeding population size, and health fitness indicates that SRKWs are more inbred than other North Pacific killer whale populations. They also have a smaller long-term effective population size and show genomic evidence of inbreeding depression. A comparison with other eastern North Pacific killer whales suggests that while inbreeding is likely to be a factor limiting SRKW recovery, the interplay between inbreeding depression and environmental factors may also contribute to the lack of recovery of the population (NWFSC unpublished data).

The age and sex class distribution is similar for both NRKW and SRKW populations (Tables 3.1 and 3.2), though there are many fewer SRKW juveniles. If we assume the NRKW population is a model of an increasing or stable resident killer whale population, we can also compare other population parameters to evaluate the delisting criteria. The previously reported average inter-birth interval for reproductive SRKW females is 6.1 years, which will allow for population growth, but likely at a slower rate than observed for NRKWs, which have a shorter inter-birth interval (Olesiuk et al. 2005). There is uncertainty in the inter-birth interval because not all births are observed. Due to the small size of the SRKW DPS, age and sex composition are more heavily influenced by individual births and deaths. More recent reproductive and demographic data can be used to re-evaluate the targets described in Olesiuk et al. (2005). This analysis assumes a range of reproductive maturity between 10 and 42 years old for both males and females (Table 3.2).

Table 3.1 Northern Resident killer whale population model described in Olesiuk et al. (2005).

Juveniles	47 %
Reproductive females	24 %
Post-reproductive females	11 %
Reproductive males	18 %

Table 3.2 Southern Resident and Northern Resident killer whale population demographics in 1979 versus levels as of October 2021 with a population of 73 whales.

	SRKW 1979 (%)	SRKW 2021 (%)	NRKW 1979 (%)	NRKW 2018 (%)
Juveniles (< 10)	37	16	33	24
Reproductive males (10+)	18	36	31	27
Reproductive females (10-42)	27	38	32	40
Post-reproductive females (>42)	19	10	4	8

The NWFSC continues to evaluate changes in fecundity and survival rates, and has updated the work on population viability analyses conducted for the 2004 Status Review for Southern Resident Killer Whales and the science panel review (Krahn et al. 2004; Hilborn et al. 2012; Ward et al. 2013). Following that work, population estimates, including data from the last five years (2017-2021), project a downward trend over the next 25 years (Figure 3.2). The declining trend is, in part, due to the changing age and sex structure of the population (the sex ratio at birth was estimated at 55% male and 45% female following current trends), but also related to the relatively low fecundity rate observed over the period from 2017 to 2021 (when the same analyses are applied to DFO's NRKW data, a similar trend of declining fecundity is also present in that population). Though these fecundity rates are declining, average SRKW survival rates estimated by the NWFSC have been slowly increasing since the late 1990s. The population projection is most pessimistic if future fecundity rates are assumed to be similar to the last five years, and higher but still declining if average fecundity and survival rates over all years (1985-2021) are used for the projections (Figure 3.2). The projection using the highest fecundity and survival rates (1985-1989) shows some stability and even a slight increase over the next decade before severely declining. Only 25 years were selected for projections because as the model

projects out over a longer time frame (e.g., 50 years), there is increased uncertainty around the estimates (also see Hilborn et al. 2012).

The scenario using the most recent (2017-2021) survival and fecundity rates may be a more reliable estimation if current levels of survival and poor reproduction continue. This predicted downward trend in the model is driven by the current age and sex structure of young animals in the population, as well as the number of older animals. The range of population trajectories reflects the endangered status of the SRKWs and variable periods of decline experienced over the long and short term and is based on a limited data set for the small population. The analysis does not link population growth or decline to any specific threat, but reflects the combined impacts of all of the past threats. As a long-lived and slow-to-reproduce species that has shown capacity to grow in the past, response to actions to limit threats will take time. It will be difficult to link specific actions to potential future improvements in the population trajectory. One assumption shared across all scenarios presented here is that female reproduction will be similar to the average (given the age of animals and time period). As many reproductive-aged females have not produced a calf in the last decade, we would expect the SRKW population to decline even more rapidly if the number of females not reproducing continues to increase, or these females continue to fail to produce calves.

Recently, Lacy et al. (2017) developed a population viability assessment (PVA) model that attempts to quantify and compare the three primary threats affecting the whales (e.g., prey availability, vessel noise and disturbance, and high levels of contaminants). This model relies on previously published correlations of SRKW demographic rates with Chinook salmon abundance using a prey index for 1979 – 2008, and models SRKW demographic trajectories assuming that the relationship is constant over time. Individual-based models, like Lacy et al. (2017), also make assumptions about the particular life stages most affected by each threat, and these inherent assumptions are known to affect results. Over the range of scenarios tested, the effects of prey abundance on fecundity and survival had the largest impact on the population growth rate. Furthermore, they suggested that for the population to reach the recovery target of a 2.3% growth rate, one scenario would be to reduce the acoustic disturbance by half and increase the Chinook abundance by 15% (Lacy et al. 2017). Based on estimates of calf mortality in bottlenose dolphins, they found that higher concentrations of PCBs could also potentially push the population from slow positive growth into decline, although to a lesser degree than prey availability. However, the authors held that eliminating or reducing this pathway of effects to SRKWs was not practical given the long timescale and costs involved in this type of recovery action.

Murray et al. (2021) updated the PVA model by incorporating new data and information on all threats and interaction of threats (Chinook abundance, vessel noise, vessel strikes, and contaminants) and then attempted to explain patterns in historical SRKW data based on the multiple threats. They found that a single threat alone could not replicate the observed patterns in SRKW population trends from 2000-2017. Only when the threats are considered together did the PVA model output most closely replicate observed trajectories in SRKWs. Another study found a significant inverse relationship between the observed demographic patterns in the SRKW population with the biennial pattern in abundance of pink salmon (Ruggerone et al. 2019); however, there is no clear mechanistic explanation for this relationship.

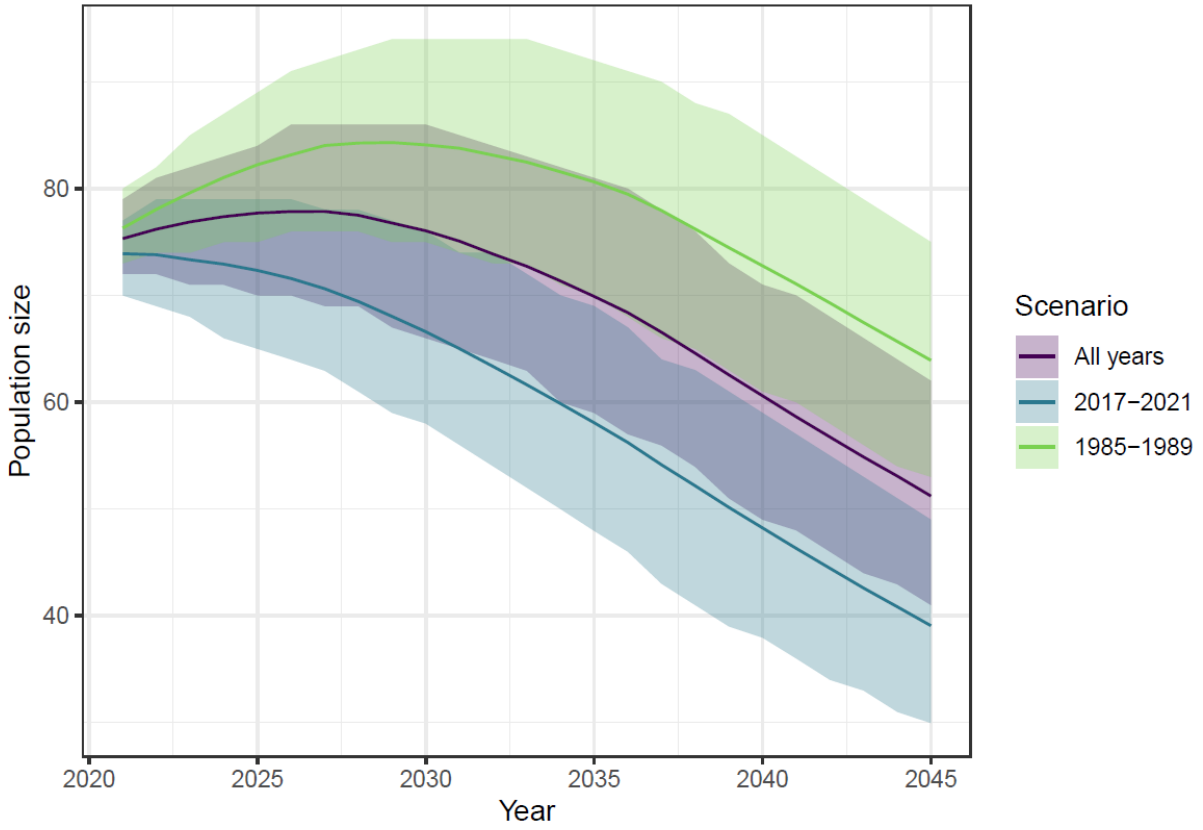


Figure 3.2 Southern Resident killer whale population size projections from 2020 to 2045 using three scenarios: (1) projections using fecundity and survival rates estimated over the entire time series (1985-2021), (2) projections using rates estimated over the last five years (2017-2021), and (3) projections using the highest survival and fecundity rates estimated, during the period 1985-1989.

Another factor to consider is the potential effects of inbreeding (generally a risk for any small population). The NWFSC continues to investigate relationships between inbreeding coefficients and demographic rates; if inbreeding has a negative effect on survival or fecundity and inbreeding is occurring in the population, the population trajectory may be more negative. Recent genetic work (Ford et al. 2018) attempted to estimate the effects of inbreeding on survival; these effects are estimated to be slightly negative, but they are also difficult relationships to estimate given the small sample size. Recent genomic analyses indicate that the SRKW population is both more inbred and carries a higher load of deleterious mutations than do Alaska resident or transient killer whales. These factors likely contribute to the SRKW's poor status. Still, the effects appear to be sufficiently small that, in an improved environment, the SRKW population should be able to grow (NWFSC, unpublished data). The 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. In addition, there are many actions underway to target recovery of critical prey, reduce vessel impacts, and better understand how several health-related factors influence reproduction. As the actions are implemented and we improve our ability to evaluate and mitigate risks, we hope to see improvements in the vital rates of the population.

These analyses provide insight into the population's current status and how demographic factors may affect future population growth, although uncertainty increases with longer-term projections. Because the population is so small, slight changes in birth rates and the sex ratio at birth can greatly influence modeled future population growth. Vital rates, and in particular fecundity, have varied over time. It is essential to continue closely tracking the population through the annual census and other studies to regularly update these projections. These models help us understand the population extinction risk, effectiveness of recovery actions, recovery potential for the population, and progress toward meeting the biological criteria.

3.3.2 Threats Criteria and ESA 4(a)(1) Analysis

The threats criteria are designed to evaluate the ESA section 4(a)(1) listing factors as they relate to the Southern Resident DPS. The same statutory factors must be considered in delisting as in listing, with objectives related to each factor included as part of the recovery criteria. As identified above under 3.2.2.2, the recovery criteria address all current threats to the species, address all five of the listing factors, and describe their relevance to the species.

Factor A: The present or threatened destruction, modification, or curtailment of a species' habitat or range.
Objective: Ensure adequate habitat to support a recovered population of Southern Resident killer whales. Habitat needs include sufficient quantity, quality, and accessibility of prey species.

Criteria:

A1. Observations indicating that lack of prey is not a source of mortality or a factor limiting recovery of Southern Residents. Consistent observations or measurements of good body condition in a significant number of individuals, and no or limited observations of reduced feeding behavior or recovery of emaciated stranded animals.

A2. Sufficient knowledge of the foraging ecology of Southern Residents to determine that established fishery management regimes are not likely to limit the recovery of the whales.
   a. Fisheries management programs that adequately account for predation by marine mammal populations when determining harvest limits, hatchery practices, and other parameters.
   b. Fisheries management programs that are consistent with recovery of salmon stocks and that support sustainable salmon populations.

A3. Contaminant levels in killer whales, prey species or surrogate marine mammal populations in the greater Puget Sound area that indicate a reduction or slowing of accumulation of legacy contaminants, such as PCBs and DDT, and information on current baseline levels of emerging contaminants. This could include data showing that overall contaminant levels in the population are decreasing or accumulation is slowing, or information that younger animals have a proportionally reduced contaminant load. A decrease in the number of contaminated sites in Puget Sound would also indicate a reduction in contaminants in a portion of the habitat of Southern Resident killer whales.

A4. Management actions in place to reduce vessel disturbance, auditory masking and risk of ship strikes. Voluntary guidelines, education programs, and prohibitions under the Marine

Mammal Protection Act (MMPA) currently in place should have remained in place. Regulations and/or protected areas should have been considered and put in place if it is determined that they will provide additional reduction in vessel effects.

Have the Threats Criteria for Factor A been met?

No, not all of the threats criteria for Factor A have been met. While there has been significant progress in assessing the habitat needs of the whales, more research is needed to help evaluate if the needs of the whales are being met, identify which factors are degrading habitat, and determine where and when the whales may be prey limited. Under Factor A and as described in our analysis of each recovery criteria related to Factor A below, effects to SRKW habitat and current levels of destruction and modification through prey availability, contaminant levels, and vessel disturbance pathways continue to pose a high risk to the whales. The high likelihood and severity of many of the threats under Factor A remain similar (see Table 2.1), and likely work in concert to present a high threat to the survival and recovery of SRKWs and continued danger of extinction.

A1. Ongoing research and analyses are being conducted to assess the health of SRKWs, evaluate whether prey is a limiting factor for their recovery, and better understand how vessels can interfere with foraging behavior. Both United States and Canadian researchers have conducted studies revealing relationships between overall coastwide Chinook salmon abundance indices and SRKW survival, social cohesion, growth rate, body condition, and fecundity (Fearnbach et al. 2011; Ford et al. 2010; Ward et al. 2009; Ward et al. 2013; Stewart et al. 2021). However, it has proved challenging to establish strong relationships between SRKW nutritional stress and Chinook salmon prey availability (Hilborn et al. 2012; PFMC 2020) or any other single causative factor.

Since 2008, NMFS' Southwest Fisheries Science Center (SWFSC) has used aerial photogrammetry to assess the body condition and health of SRKWs, initially in collaboration with the Center for Whale Research and the Vancouver Aquarium and, more recently, with SeaLife Response, Rehabilitation, and Research (SR3). Aerial photogrammetry studies have provided finer resolution for detecting poor condition, before malnutrition manifests in the sunken necks or "peanut heads" observable from boats. Annual aerial surveys of the population from 2013-2017 (with exception of 2014) have detected declines in condition before the death of seven SRKWs (L52 and J8 as reported in Fearnbach et al. (2018); J14, J2, J28, J54, and J52 as reported in Durban et al. (2017)), including five of the six most recent mortalities (Trites and Rosen 2018). However, these studies used a body condition metric that is variable across the growth stages and may not accurately represent improving or declining health (Fearnbach et al. 2019). Furthermore, morphometric body condition assessments do not provide information on the cause of reduced body condition. In one study, a hormone analysis from fecal samples suggested that prey availability may be a greater physiological stressor on SRKW than vessel presence due to differences in concentrations of glucocorticoids and a thyroid hormone (Ayers et al. 2012). However, hormone concentrations vary naturally by season, as do vessels and prey availability, which potentially confounds interpretation of these results.

A recent study utilized seven years of aerial photographs and documented body condition in individual SRKWs over time (99 individuals across all three pods) (Stewart et al. 2021). The authors examined several variables to estimate the probability that an individual whale's body condition would improve, decline, or remain stable across years. They estimated the Chinook abundance of the previous year using the eye patch ratio, which measures the fatness behind the cranium and is robust to variation in surfacing orientation and changes in body proportions with growth (Fearnbach et al. 2019). Importantly, the authors used age- and sex-normalized body condition classes to account for variability in size and nutritive condition. Fraser River and Salish Sea Chinook salmon stocks showed the greatest predictive power with J pod body condition, showing a strong negative relationship between the probability of body condition decline and Chinook abundance (Stewart et al. 2021). L pod body condition was better explained by Puget Sound Chinook salmon abundance, though the relationship was weaker than the relationship between J pod body condition and Fraser Chinook abundance. The relationship with L pod was difficult to interpret. L pod spends less time in the Salish Sea than J pod (especially in the most recent decade) and Puget Sound Chinook are outnumbered by other Chinook stocks in the North of Falcon[2] (NOF) areas. For K pod, the best model did not include any Chinook abundance covariates, and body condition was relatively constant over time. However, the models including Chinook abundance generally performed only marginally better than the null model, suggesting other factors may contribute to body condition shifts. Continued work is needed to interpret other factors, including competitive effects (competition from other SRKW pods, and other whale populations, like NRKWs).

Additionally, Stewart et al. (2021) found that whales in poor body condition had mortality probabilities 2-3 times higher than whales in more robust condition. This paper reflects advancements in interpreting body condition data and the importance of continued non-invasive monitoring through photogrammetry. Although specific thresholds have yet to be determined for identifying consistent "good" body condition over time, future studies will identify seasonal patterns of nutritional status and assess the contributions of other Chinook stocks or salmonid species on the physical status of SRKWs. In another recent paper, the probability of prey capture was reduced in SRKWs when salmon abundance was lower (Holt et al. 2021a), suggesting that there may be multiple pathways to nutritional stress when prey are limited.

A recent paper aimed to quantify differences in prey availability between the declining SRKW population and the growing NRKW population, both of which rely heavily on Chinook salmon but occupy adjacent and minimally overlapping habitats. Acoustic methods were used to identify the prey field along predetermined transects (Sato et al. 2021). In the summer months (July-August) of 2018 and 2019, the study found comparable prey patch frequencies and prey size between the two habitats, but that that prey density within patches was higher in SRKW habitat (Sato et al. 2021). The portion of SRKW habitat surveyed in this study includes areas in the Strait of Juan de Fuca where some prey samples have been collected along Vancouver Island, B.C. (Hanson et al. 2010), and where recent observations have identified travel as the predominant behavior (DFO 2021). Sato et al. (2021) identified

[2]The North of Cape Falcon (NOF) management area encompasses the Washington coast and northern Oregon (the coastal waters from U.S./Canadian border to Cape Falcon, OR).

challenges in using acoustic methods to evaluate prey fields and noted other factors that were not analyzed, such as prey energy content or how vessel presence or sound may influence accessibility of prey. Prey availability is highly variable and additional research would be needed to better understand prey limitations for SRKW, such as evaluating prey in other regions of the whales habitat and different seasons throughout the year, and determining whether prey patch frequency or prey patch density is more important for killer whale foraging ecology.

Necropsy studies from stranded animals can provide more direct evidence of poor body condition and cause of death. In 2020, Raverty and coauthors compiled data from 35 stranded killer whales (all ecotypes) from 2001 to 2017 to assess the relationship among killer whale morphometrics, blubber thickness, body condition, and cause of death. A body condition index (BCI) was calculated as a ratio of the girth at the anterior dorsal fin insertion and total body length. Taking into account the animal's age, malnutrition was almost always the cause of death for individuals with low BCIs (worst body condition), though no SRKW were included in that analysis. However, it is important to note that some of the lowest BCIs were reported for individuals that died from infections. Poor body condition in whales can be influenced by a number of factors, including reduced prey availability, reduced ability to forage successfully, increased energy demands, physiological or life history status, disease, or reduced intestinal absorption of nutrients (Raverty et al. 2020). However, since the last 5-year review, none of the stranded SRKWs for which necropsies were conducted died of nutritional stress (causes of death included trauma and fungal infection) (Raverty et al. 2020; Caretta et al. 2021), although the female neonate was also in poor body condition and emaciated at the time of death (S. Raverty, pers. comm.).

In 2018, an international team of biologists launched an emergency response effort for J50, a severely emaciated 3-year old SRKW. Responders from NMFS and partner organizations explored options ranging from no intervention to providing medical treatment and prepared contingency plans to potentially rescue her and provide short-term care in the event she stranded or separated from her pod. Remote medication was administered, but unfortunately, J50 was not seen after mid-September 2018. She was presumed dead and not included in the census the following year. Health samples were collected; however, the cause of her emaciation was never determined.

Although nutritional stress is a possible cause of poor body condition or reduced body condition over time (e.g., Stewart et al. 2021), other factors such as disease, organ malfunction, vessel disturbance, and prey contamination can also contribute to the conditions observed in aerial photogrammetry studies and necropsies. More research into these confounding factors and their effects on the whales is needed to understand how external influences affect SRKW health.

More research, for example, is needed to understand how vessel activity affects the whales. Reduced feeding behavior has been reported when vessels are near SRKWs. Studies have shown that the whales spend more time traveling and performing surface-active behaviors and less time foraging when in the presence of all vessel types, including kayaks (Holt 2008; Lusseau et al. 2009; Noren et al. 2009; Williams et al. 2010; Bubac et al. 2020). Further,

noise from or presence of motoring vessels up to 400 meters away has the potential to affect the echolocation abilities of foraging whales and their foraging dives and success (Holt 2008; Lusseau et al. 2009; Williams et al. 2010; Holt et al. 2021a, 2021b), or probability of being in a foraging state (Williams et al. 2021). New models of SRKW behavioral states showed that both males and females spent less time in foraging states, with fewer prey-capture dives and less time spent in prey capture dives, when vessels were near (within 400 yds on average) (Holt et al. 2021b). The impact was greater for females, who were more likely than males to switch from deep and intermediate dive foraging behaviors to travel/respiration states when vessels were near (Holt et al. 2021b).

Individual energy balance may be impacted when vessels are near the whales because of the increase in energetic costs resulting from (1) changes in activity, and (2) the decrease in prey consumption resulting from reduced foraging opportunities (Williams et al. 2006; Lusseau et al. 2009; Noren et al. 2009; Noren et al. 2012, 2016; Holt et al. 2021a, 2021b). In a recent study, SRKWs had a lower predicted probability of capturing prey when nearby vessel (within 1.5 km) speeds were higher (Holt et al. 2021b). Given that vessel speed is one of the strongest predictors of underwater noise (Houghton et al. 2015), faster moving vessels appear to have a greater impact on energy intake in SRKW, including vessels located farther than the closest allowed distance (200-400 yds) for viewing the whales, and those beyond the current speed restriction distance (half nautical mile). However, it is difficult to determine the cumulative impacts of the multiple vessel approaches on individual whales and the population. Further, the study found that prey capture dive duration and the speed of descent varied in the presence of echosounders emitted by vessels with received levels of noise, and with vessel distance (Holt et al. 2021a). Importantly, the authors found that the probability of prey capture was positively correlated with prey abundance, suggesting that in years of low prey abundance, vessel impacts may compound the stressor of food availability. In another study, vessel speed did not predict foraging behavior, but estimated levels of sound impacted the probability of foraging (Williams et al. 2021). These results highlight the impact that vessels and their sounds have on SRKW foraging behavior, energy acquisition, and potentially, energetic expenditure. Actions to address the impact of vessels are discussed in more detail below under the A4 and B1 delisting criteria.

Overall, while body condition assessments provide some insight into the state of an individual's health, it is still difficult to determine the ultimate cause of poor body condition. SRKW condition may be impacted by reduced prey availability, reduced access to prey via vessel impacts, disease, or other factors mentioned above. While there has been significant progress in our understanding of the stressors that impact SRKWs, it is complicated to identify the cumulative and interactive effects of multiple stressors. In a recent study, DNA methylation patterns of genes involved in the stress response were compared for SRKW and NRKW populations (Crossman et al. 2021). Methylation patterns did not vary across age or sex, but differences were detected between the two populations, highlighting their exposure to different stressors in the external environment (Crossman et al. 2021). This finding is an important step forward in identifying the impact of cumulative effects of multiple stressors, though the biological implications of these differences are still unknown.

A2. In the last five years, scientific research has furthered our knowledge of foraging ecology and the potential effects of fisheries on the whales. Diet studies provided information on seasonality and distribution of consumed prey, which help to inform fisheries impacts and salmon management strategies. Previous work using scale and tissue sampling from prey remains has established that the SRKW diet (in inland waters of Washington and British Columbia) consists of a high percentage of Chinook salmon during the summer months of May-September if the whales are in Salish Sea waters (monthly proportions as high as >90%) (Hanson et al. 2010; Ford et al. 2016). A new study released in 2021 characterized the winter and coastal diet of SRKWs using both fecal prey metabarcoding and scale/tissue samples. Prey remains and fecal samples collected in inland waters during October through December confirmed that Chinook and chum salmon are primary contributors to the whales' diet (Hanson et al. 2021).

Prior to 2013, only three prey samples for SRKW on the U.S. outer coast had been collected (Hanson et al. 2021). From 2013 to 2016, researchers used satellite tags to locate and follow the whales to obtain predation and fecal samples. They collected a total of 57 prey sample items from northern California to northern Washington. The samples indicate that, as is the case in inland waters, Chinook are the primary species detected in diet samples on the outer coast, although steelhead, chum, and Pacific halibut were also detected in samples. Foraging on chum and coho salmon, steelhead, Big skate and lingcod was also detected in recent fecal samples (Hanson et al. 2021). These data indicate that the whale diet diversifies when Chinook salmon is less abundant (Hilborn et al. 2012; Ford et al. 2016; Hanson et al. 2021). 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.

Recent stable isotope analyses of opportunistically collected prey scale samples (Warlick et al. 2020) continue to support and validate previous diet studies (Ford et al. 2016) and what is known of SRKW seasonal movements (Olson et al. 2018), but highlight temporal variability in isotopic values. Warlick et al. (2020) continued to find that Chinook is the primary prey for all pods in the summer months, followed by coho and then other salmonids. Carbon signatures in samples varied by month, which could indicate variation in Chinook and coho consumption between months or differences in carbon signatures across salmon runs and life histories. Peaks in carbon signatures in samples varied between K/L pod and J pod. Though Chinook was the primary prey across years, there was inter-annual variability in nitrogen signature in samples, which could indicate variation in Chinook nitrogen content from year to year or greater Chinook consumption in certain years versus others and/or nutritional stress in certain years, but this is difficult to determine.

In addition to scientific research, evaluations of fisheries and management actions provide a mechanism to further SRKW recovery. Salmon harvest actions are evaluated under Section 7 of the ESA to ensure that federal harvest management regimes will not jeopardize the continued existence of ESA-listed species nor adversely modify their designated critical habitat. These ESA consultations have considered both short- and long-term effects of salmon fisheries on SRKWs via prey reduction and fishery operation. In the last five years, NMFS has completed consultations on several fisheries including Puget Sound salmon fisheries (NMFS 2016b; 2017b; 2018a; 2019b, 2020e, 2021), PFMC-area salmon fisheries

(NMFS 2020f, 2021), the Columbia River salmon fisheries (NMFS 2018b), and salmon fisheries in Southeast Alaska managed under provisions of the PST (NMFS 2019c). The biological opinions produced from these consultations contain the most updated information on SRKW foraging ecology and consider published papers from all sources, including unpublished data from the NWFSC.

Salmon fisheries effects that are anticipated on an annual basis are considered short-term (i.e., number of harvested Chinook salmon in a given year), while the potential effects of an action on overall population viability of prey are considered long-term effects (i.e., Chinook salmon stock, ESU, or DPS viability). In consultations over the last five years, we estimated that short-term prey reductions from fisheries are small relative to estimates of total Chinook salmon population size. Likewise, we estimated that the harvest actions under consultation met the long-term conservation objectives of harvested stocks, and were not likely to appreciably reduce the survival or recovery of listed Chinook salmon. Therefore, in all of the harvest consultations referenced above from the last five years, NMFS concluded that the harvest actions cause small prey reductions, but were not likely to jeopardize the continued existence of ESA-listed Chinook salmon or SRKWs, nor adversely modify their critical habitats. Some of these harvest actions included specific measures to address the prey needs of SRKWs as described below.

In 2018, NMFS and WDFW, with input from other partners, produced a Priority Chinook Stocks Report that included a list and ranking of Chinook stocks that are important for the SRKW prey base. The list was created using information on (1) Chinook salmon stocks found in SRKW diet through scat and prey scale/tissue samples, (2) SRKW body condition over time through aerial photographs, and (3) SRKW spatial and temporal overlap with Chinook salmon stocks ranging from southeast Alaska to California. Extra weight was given to the salmon runs that support SRKWs during times of the year when the whales' body condition is more likely reduced and when Chinook salmon may be less available, such as in winter months. The report, including a summary of priority stock descriptions, is available at https://archive.fisheries.noaa.gov/wcr/publications/protected_species/marine_mammals/killer_whales/recovery/srkw_priority_chinook_stocks_conceptual_model_report___list_22june2018.pdf. This priority stock report will continue to be updated over time as new data become available.

In 2019, the PFMC convened the SRKW Ad Hoc Workgroup to reassess the impacts of the PFMC ocean salmon fisheries. The Workgroup developed a long-term approach that included proposed conservation measures or management tools to limit PFMC salmon fishery impacts on Chinook salmon prey availability for SRKWs. The Workgroup attempted to predict the effects of Chinook abundance reduction due to PFMC ocean salmon fisheries on SRKW performance metrics. Results suggested that any fisheries effects on SRKW were relatively small. Additionally, the Workgroup attempted to quantify the relationship between Chinook abundance and SRKW demographics to relate past SRKW demographic performance metrics with estimates of the starting abundance of Chinook salmon from 1992-2016 (PFMC 2020). Similar to past efforts (e.g., Hilborn et al. 2012; Ward et al. 2013), the Workgroup found predicting the relationship between SRKW demographics and Chinook salmon abundance to be challenging because of the small sample sizes. The relationships

appeared weaker in the Workgroup analyses than those from prior analyses (PFMC 2020; Ford et al. 2010). The Workgroup considered hundreds of regressions and would expect 5% to be statistically significant by chance alone; of these regressions, one met the criterion of statistical significance ($p \leq 0.05$) (winter Chinook abundance NOF and SRKW survival with one-year time lag, $p = 0.0494$) and several regressions had $p \leq 0.10$ in times and areas with likely whale presence. Although the Workgroup emphasized that caution is warranted when interpreting regression results given the limitations of the data, they concluded that these results, coupled with the potential occurrence of SRKWs in the NOF area in all seasons (based on other data, such as the acoustic recorder or satellite tag data), suggest that Chinook salmon abundance in NOF coastal areas may be most consistently important to the whales. Instead of pursuing a model-based approach that relied on the demographic data, the Workgroup developed an alternative approach based on the desire to avoid extremely poor Chinook abundance in the NOF coastal region. Based on these findings, the Workgroup provided a list of recommended alternatives suggesting that the PFMC establish a threshold for low Chinook abundance in the NOF area below which management actions would be triggered (e.g., quota adjustments and spatial/temporal closure). A recommendation was incorporated in Amendment 21 for the Pacific Salmon Fishery Management Plan (see Section 2.2) that was approved by NMFS (86 Fed. Reg. 51017). The recommendation established a threshold representing a low pre-fishing Chinook salmon abundance in the NOF area (including the Exclusive Economic Zone (EEZ) and state ocean waters), below which the Council and states would implement specific management measures (NMFS 2021b). See the whole Pacific Coast Salmon Fishery Management Plan through Amendment 21 at https://www.pcouncil.org/documents/2016/03/salmon-fmp-through-amendment-20.pdf/.

In summary, the inclusion of a threshold and management actions to specifically address the prey needs of SRKWs during periods of low Chinook salmon abundance is an important step in ensuring fishery management is not likely to limit the recovery of the whales.

We also work closely with the co-managers of Puget Sound salmon fisheries, Puget Sound Treaty Indian tribes, and WDFW, to assess impacts to SRKW from their annual fishery seasons. Vessels associated with the Puget Sound commercial and recreational salmon fisheries overlap with SRKWs primarily in the San Juan Island and southern Strait of Georgia area, recreational marine area 7 (R-MA 7), and commercial areas 7 and 7A, in July through September, based on known occurrence of SRKWs in the Salish Sea. These are key foraging areas for the whales during summer months, especially in September in recent years. SRKWs overlap with fisheries in other Puget Sound marine areas as well, though to a lesser degree. Annually, the Puget Sound salmon fisheries co-managers take actions to reduce the fisheries' impacts to SRKW. For example, in 2021, actions included fishery closures or Chinook salmon non-retention requirements in certain months and areas, low overall percent reduction (approx. 3%) of total Chinook salmon abundance, and continued implementation, education, and enforcement of regulations and voluntary guidelines for boating near SRKWs (NMFS 2021a).

For tribal fishing within Puget Sound, Chinook salmon harvest predominately occurs in terminal areas (77%) where salmon have escaped predation by SRKW (areas close to the river mouth or in-river). Many tribal pre-terminal fisheries are directed at other salmon

species, with Chinook salmon catch being incidental, or in times and areas where SRKWs encounters are not expected or rare. A full analysis of the impacts of Puget Sound Chinook fisheries can be found in the latest biological opinion (NMFS 2021a).

a. Models used for salmon harvest management, such as the Fishery Regulation Assessment Model (FRAM) (described in NMFS 2008b), account for natural mortality by calculating the difference between counts of smolts exiting rivers and counts of adults returning to the rivers while considering the number of fish harvested. Therefore, natural mortality is not calculated based on estimates of marine mammal consumption. Further, marine mammal consumption of Chinook salmon in coastal and inland waters has likely increased over the last 40 years. Chasco et al. (2017a) used a spatial, temporal bioenergetics model to estimate Chinook salmon consumption by four marine mammals – harbor seals, California sea lions, Steller sea lions, and fish-eating killer whales – within eight regions of the Northeast Pacific, including areas off the U.S. West Coast. Chasco et al. (2017a) determined that the number of individual salmon, including smolts, consumed by marine mammals in the entire Northeast Pacific (including inland waters of Salish sea) has increased from 5 to 31.5 million individual salmon from 1975-2015 (including juveniles). This amount includes an increase from 1.5 to over 3.9 million adult salmon consumed in the Northeast Pacific on average across model parameter uncertainty. Consumption of all salmon ages by pinnipeds in Puget Sound has increased from 68 to 625 metric tons from 1970 to 2015 (Chasco et al. 2017b). With this increase, based on dietary/energy needs and 2015 marine mammal abundances, Chasco et al. (2017a) calculated that when species occur in inland waters of the Salish Sea, SRKWs would consume approximately 190,215 adult salmon (age 2 and older), harbor seals would consume 346,327 salmon age 2+, and California sea lions and Steller sea lions combined would consume approximately ~60 adult salmon (sea lions mainly consume smolts). Though these values represent a model scenario based on the energetic demands and diet preferences of marine mammals (where there is consistent salmon abundance), the estimates provide a general indication of how many Chinook salmon need to be consumed to meet the biological needs of marine mammals. In summary, predation on Chinook salmon by killer whales and pinnipeds has increased in the last 40 years, with pinniped consumption now exceeding that of resident killer whales, and marine mammal consumption exceeding that of fishery harvest (Chasco et al. 2017a, 2017b).

   In summary, though abundance of Chinook salmon available at the beginning of a year (modeled in FRAM) across the SRKW range is substantially greater than the required amount of salmon needed by SRKWs, the availability to SRKWs would be reduced based on dietary needs of other marine mammals as well as other predators (e.g., pelagic fish and sharks, and birds). Therefore, there is likely competition between SRKWs and other predators that consume adult Chinook. There is also no available information on the whales' foraging efficiency, so it is unknown how much more fish (beyond energetic demand) need to be available for the whales to consume enough prey to meet their needs. Therefore, it is difficult to evaluate how much Chinook salmon or what density of salmon needs to be available to the whales for survival and successful reproduction.

More advanced models have been developed to refine Chinook salmon abundance estimations by region, taking into account spatial and temporal distribution of different stocks along the West Coast (Shelton et al. 2019). Natural mortality estimates have yet to be updated based on the new information described above.

Following recommendations put forth by the Governor's Task Force, WDFW is leading efforts to refine estimates of marine mammal (and bird) predation on salmonids. A recent paper quantified the contribution of juvenile Chinook and coho in the harbor seal diet in Puget Sound, and extrapolated to estimate the impact on the prey populations (Nelson et al. in press).

b. As described above, NMFS conducts ESA Section 7 consultations to ensure that fisheries do not jeopardize the continued existence of ESA-listed salmon. More detail can be found in the biological opinions produced for the consultations in the last five years (referenced above). For additional information on salmon fishery consultations, including a description of the approach for harvest decisions for ESA-listed salmon and steelhead, please visit http://www.westcoast.fisheries.noaa.gov/fisheries/salmon_steelhead/salmon_and_steelhead_fisheries.html.

A3. Recent work evaluating baseline contamination in killer whales is discussed in Section 3.4.2. POPs remain a concern for SRKWs despite many federal and state-wide efforts to ban or stop the production of certain contaminants. Although some biopsy studies have indicated that the concentration of PCBs in male killer whales has decreased since the 1990s (Ross et al. 2000; Krahn et al. 2007), 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. A recent study that modeled food web bioaccumulation found PBDE levels in SRKWs (but not NRKWs) above the toxicity reference level for marine mammals (Alava et al. 2016). Based on declining concentrations found in other species and their discontinued production in the U.S. and Canada, the accumulation of PBDEs in SRKWs is expected to slow in a similar fashion to PCBs (Elliott et al. 2005; Law et al. 2010; West et al. 2011; Ross et al. 2013; Mongillo et al. 2016). However, a recent study found that PBDE concentrations in SRKWs may be increasing, and that PCBs remain a concern (Guy 2018). Further, 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).

Although our understanding of contaminant loading in killer whales has grown significantly since SRKWs were listed, there is no strong evidence for a marked reduction in contaminant load in SRKWs, nor a proportionally reduced load in calves. Regular monitoring would provide critical information on changes in contaminant level or exposure over time. One recent study found a positive correlation between blubber and blood POP concentrations, which shows that circulating POPs are reflected in blubber contaminant profiles (McCormley et al. 2021) and may support health and immune function assessments. Recent efforts to measure POPs in killer whale fecal samples have been successful, with SRKW fecal contaminant concentrations matching their blubber concentration (Lundin et al. 2016a). Fecal

samples will be a critical, non-invasive resource for contaminant monitoring moving forward.

Future studies should continue to focus on correlating physiological stress with contaminant loads to provide evidence for the health effects of POPs on SRKWs (Ayres et al. 2012; Gockel & Mongillo 2013; Lundin et al. 2016a), which would facilitate the establishment of an effects threshold for morbidity. However, contaminant effects cannot be considered in isolation, as synergistic, additive, or antagonistic interactions may shape their impacts on whale health. For example, a recent study found that toxicant concentration was higher in SRKWs during low-Chinook years, and the potential for toxicity was highest with low prey abundance (Lundin et al. 2016b). As fat stores get metabolized in the absence of adequate food, the contaminants are mobilized, causing increased exposure to the whale or a nursing calf (Noren et al. 2018). Therefore, nutritional stress from reduced prey, including Chinook salmon that contain higher levels of some POPs than other salmon species (Krahn et al. 2007; O'Neill and West 2009; Veldhoen et al. 2010; Mongillo et al. 2016), may act synergistically with high pollutant levels in killer whales and result in adverse health effects.

A4. NMFS has taken several steps to reduce vessel disturbance to SRKWs, the most significant of which has been implementing mandatory regulations in 2011 (76 Fed. Reg. 20870, April 14, 2011). The final federal regulations include (1) a prohibition on approaching killer whales within 200 yards, and (2) a prohibition on parking in the path of killer whales out to 400 yards in inland waters of Washington State. The regulations were developed using the best available science and consideration of public input in order to provide adequate protection for the whales while allowing for an educational and economically viable whale watching industry. WDFW enacted state regulations with similar requirements in 2012, as did Canada in 2018.

In 2019, Washington State enacted new regulations on whale watching to further reduce impacts to SRKWs, as recommended by the Governor's Task Force. The regulations include (1) a prohibition on approach within 300 yards on either side of a Southern Resident, (2) a prohibition on approach within 400 yards in front or behind a whale, (3) mandatory speed reduction to 7 knots within a half nautical mile of a whale, and (4) mandatory disengagement of the engine if a whale appears within 300 yards (see RCW 77.15.740). Similarly, Canada increased protections for killer whales from vessel impacts in 2019, 2020 and 2021 by implementing annual interim regulations, while they continue to consider permanent regulations through a formal rulemaking process. These interim measures increased the viewing distance from 200 meters to 400 meters in all directions and designated several interim sanctuary zones that prohibit vessels from entering. Although the distance regulations have not changed since 2019, the interim sanctuary zones and the geographic scope of the measures were adjusted in 2020 and 2021.

NMFS recently completed a public scoping process to gather input on the need for potential updates to federal vessel regulations (84 Fed. Reg. 57015, October 24, 2019) and is working with Washington State and Canada to discuss alignment of any potential future regulations.

Many studies provided evidence for the vessel regulations and new studies continue to improve our understanding. Previously, researchers studying the surface behaviors of NRKWs and SRKWs found that whales spend more time traveling and less time foraging when vessels are nearby, indicating that they should maintain a greater distance from the whales in inland waters, which serve as important foraging areas (Lusseau et al. 2009; Williams et al. 2010; Noren and Hauser 2016). A 2021 paper published by the NWFSC confirmed these observations by using digital acoustic tags (DTAGs) to study the subsurface behavior of SRKWs (Holt et al. 2021b). They found that individuals made fewer deep foraging dives involving prey capture and spent less time in this foraging state when the average distance to nearby vessels was less than 400 yards. Furthermore, females switched from foraging states to traveling states at a greater rate than males in the presence of close vessels (Holt et al. 2021b). This disproportionate impact on the foraging success of females has implications for greater population-wide consequences, as it may also impact their reproductive success.

In addition to proximity to the vessels, the NWFSC study using suction cup DTAGs found that the speed of nearby vessels is an important indicator of the level of noise received by the whales at a given distance (Houghton et al. 2015). Although the federal regulations codified in 2011 do not include a restriction on speed, the Be Whale Wise guidelines recommend a slow zone up to 400 meters away from the whales at all times, and in 2019 Washington State added a speed limit of 7 knots within a half-mile of the whales. In addition to reducing sound, speed guidelines and regulations will also reduce the risk of vessel strikes.

Other recent studies indicate that noise from large ships extends into frequencies used by SRKWs for echolocation. This means vessels not targeting the whale can still cause disturbance and impair the whales' ability to find food, should they continue foraging when vessels are present (Veirs et al. 2016). A recent study assessed the spatial noise exposure risk in the summer core area used by SRKW (Cominelli et al. 2018). Voluntary slow-down trials instituted in Canadian waters for commercial vessels show reductions in the level of ambient noise in the broadband range and at frequencies used by SRKWs (Joy et al. 2019; MacGillivray et al. 2019; Burnham et al. 2021). A recent paper analyzed the effects of the voluntary vessel slow-down on SRKW foraging and found that the received noise level predicted the probability of being in a foraging state (Williams et al. 2021). This information and the success of voluntary slow-downs in Canada (see ECHO reports at https://www.portvancouver.com/environmental-protection-at-the-port-of-vancouver/maintaining-healthy-ecosystems-throughout-our-jurisdiction/echo-program/echo-program-annual-reports-and-peer-reviewed-papers/) supported Recommendation 22 in the Governor's Task Force Report, which suggested that the U.S. develop an equivalent program to Canada's ECHO program to address effects of acoustic and physical disturbance from large commercial vessels. This new U.S. program, Quiet Sound, will benefit from these vessel studies, data on the effectiveness of recent Canadian measures, and information on the ambient soundscape in Washington waters. The NWFSC is continuing DTAG data analysis in partnership with DFO to determine how vessel-generated noise influences the subsurface behavior of Southern Residents, especially foraging behaviors. The NWFSC is currently focused on learning more about foraging and potential impacts from large ships at night.

NMFS continues to work with Washington State and non-profit partners to enforce the regulations and advance education campaigns to raise boater awareness. In 2016 and again in 2019, WDFW received 3-year ESA Section 6 grants to assist enforcement efforts. The Soundwatch Boater Education Program ("Soundwatch") through the Whale Museum records data on vessels near the whales, incidents of vessels not following regulations and guidelines, and educates boaters on state and federal regulations and the Be Whale Wise guidelines (see Seely et al. 2017). NMFS has also continued to promote the voluntary Be Whale Wise guidelines through Soundwatch, WDFW, the Seattle Aquarium, Orca Network, and other partners. Additionally, the San Juan County Marine Resources Committee has introduced a Whale Warning Flag that boaters can fly when whales are in the area to notify nearby vessels to adjust behavior and comply with the Be Whale Wise guidelines. More details can be found at https://www.sjcmrc.org/other-content/whale-warning-flag/. Straitwatch, a similar entity to Soundwatch, monitors vessel activity around the whales in the Strait of Juan de Fuca. Their report on vessel observations near SRKW from 2018-2020 can be found at https://www.cetussociety.org/straitwatch.

In summary, NMFS and our partners have made significant progress in implementing management actions to reduce vessel disturbance, auditory masking and risk of ship strikes, and MMPA protections remain in place. Protective regulations and protected areas have all been considered and federal, state, and Canadian regulations have been put in place and updated. Canada has implemented interim sanctuary zones in recent years. The long-standing voluntary no-go zone along the west side of San Juan Island is now a required no-go zone for commercial whale watch vessels (see B.1 below). As outlined in Ferrara et al. (2017), while these protections have provided some benefits for the whales, there remains room for improvement in getting educational messages out to boaters, increasing compliance with existing rules, and considering more protective measures to further reduce vessel impacts to the whales (see delisting criterion D2 for additional details on the evaluation). NMFS received a petition to establish a required regulatory no-go zone in 2016 and opened a public comment period on the petition in 2017 (82 Fed. Reg. 4276, January 13, 2017). NMFS did not accept that petition as written and, as mentioned above, is currently scoping the need for a broader range of potential updates to the federal regulations (84 Fed. Reg. 57015, October 24, 2019) that reflect state and Canadian rules, lessons learned from implementation and enforcement, and new scientific results that have become available in recent years.

Factor B: Overutilization for commercial, recreational, or educational purposes
Objective: Ensure commercial, recreational or educational activities are not affecting the recovery of Southern Residents, including vessel effects from whale watching.

Criteria:

B1. Reduction in impacts from commercial and recreational whale watching, or evidence that this activity does not cause population level effects. Reductions may be measured through fewer incidents reported in the vicinity of whales, increased audiences for education programs and establishment of regulations or protected areas if needed (see Criterion A4).

B2. No permanent removals of individual Southern Residents from their habitat, including live capture for public display, and any incidental takes associated with fisheries or other commercial or recreational activities have been addressed through regulatory mechanisms to insure against recurrence.

Have the Threats Criteria for Factor B been met?

Some of the criteria for Factor B have been met. There are no requests or authorizations for removals of SRKWs. NMFS has also made progress in addressing overutilization of SRKWs by developing regulations to reduce vessel disturbance, and Washington State has implemented a commercial whale watch licensing program. Under Factor B and as described in our analysis of the recovery criteria below, SRKWs continue to face overutilization through vessel impacts with low risk from removals. The moderate to high likelihood and severity from vessel effects under Factor B remain similar (see Table 2.1), present a moderate to high threat, and contribute to continued danger of extinction.

B1. Actions to reduce vessel disturbance are described above under the A4 delisting criteria, and in Sections 2.3 and 2.6. Federal and state regulations are intended to reduce the number of potentially harmful incidents when vessels are not following the responsible viewing guidelines. A recent NMFS technical memo (Ferrara et al. 2017) analyzed the effectiveness of the regulations (described in D2 of the downlisting criteria).

In 2021, Washington implemented a Commercial Whale Watch Licensing Program (CWWLP), which resulted from the Governor's Task Force recommendations. The CWWLP requires commercial operators to maintain a commercial whale watching license to view SRKWs. The Washington State legislature established the licensing fees (RCW 77.65.615) and directed WDFW to adopt rules for companies operating under a commercial whale watching license (RCW 77.65.620) in July of 2019. WDFW convened an ad-hoc advisory committee—consisting of members of the commercial whale watching industry and NGOs—as well as an independent science panel and an intergovernmental coordination group from January through August of 2020 to develop these rules, which were adopted by the Fish and Wildlife Commission in January 2021 (WSR 21-01-216). In addition to requiring compliance with state and federal regulations for operating a vessel near SRKWs, the CWWLP rules place additional restrictions on the number of commercial vessels within a half nautical mile of SRKWs, the time of day and year that commercial viewing of SRKWs is allowed, and the number of trips a commercial operator can make to view SRKWs in a day. The CWWLP also imposes certain reporting requirements on commercial operators and prohibits licensees

from entering the voluntary no-go zone on the west side of San Juan Island, as outlined in the Be Whale Wise guidelines.

NMFS continues to work with WDFW and Soundwatch to monitor vessel activity around the whales, track outreach to a variety of audiences, and evaluate trends in the number of incidents of vessels not following guidelines and regulations. An annual report provided by Soundwatch summarizes trends in vessel-based whale watching activities near SRKWs. The annual Soundwatch reports can be found at https://whalemuseum.org/pages/soundwatch-boater-education-program.

A paper from 2017 summarized trends from the previous 18 years of data from the Soundwatch program. It found that the number of commercial whale watching vessels had increased since 1999, with 96 vessels reported in 2015 (Seely et al. 2017). In 2020, only 68 commercial whale watching vessels were recorded, likely due to pandemic operational changes (Frayne 2021). The number of recorded vessel incidents (not following regulations or guidelines) also increased from 1999-2017, suggesting that continued on-the-water education efforts are necessary (Seely et al. 2017). However, since 2017, the number of recorded vessel incidents has declined from approximately 6.9 incidents per hour in 2017 to approximately 1.5 incidents per hour in 2020 (Frayne 2021). In 2020 recreational vessels accounted for the majority (96%) of vessel incidents (Frayne 2021), and new efforts by Washington State Parks aim to improve education on best boater practices, including adding the regulations and guidelines to the Washington State Boater Education Course curriculum, and short educational videos shared through social media outlets online.

B2. The public display industry has not requested authorization to remove SRKWs from the wild, and NMFS has not authorized any live captures. Incidental take in fisheries is not currently a threat to SRKWs, though observer coverage levels are low (Caretta et al. 2021) and ship strikes are infrequent. However, potentially harmful interactions with fishing gear and vessels do sometimes occur (Raverty et al. 2020). In 2016, an 18-year old male, J34, was found dead near Sechelt, British Columbia. The necropsy indicated that the whale died of blunt force trauma to the head, and Raverty et al. (2020) determined this was consistent with a vessel strike. While it is unknown what vessel type was involved in this interaction, NMFS continues to rely on reports of vessel strikes or incidental take in fisheries from the fishing community, from observers, from vessel operators, or through stranding investigations to monitor changes in take frequency.

Factor C: Disease or predation
Objective: Ensure that diseases and their effects on reproduction and survival are not a threat to the sustainability of the Southern Resident DPS.

Criteria:
C1. Sufficient knowledge to determine that disease is not limiting the recovery of Southern Resident killer whales.

Have the Threats Criteria for Factor C been met?

No, the threats criteria for Factor C have not been met. Recent studies characterizing commensal microbial compositions in killer whales (described below) are useful for establishing our understanding of baseline whale physiology. However, emerging pathogens may be of concern. Additional monitoring is needed to ensure that diseases are not affecting reproduction and survival of Southern Residents. Under Factor C and as described in our analysis of the recovery criterion below, SRKWs still face unknown risks of disease or pathogens in the marine environment. While the severity of disease under Factor C remains potentially high, the likelihood continues to be low based on our ongoing monitoring (see Table 2.1). Disease presents a moderate threat to the survival and recovery of SRKWs.

C1. While the social structure and small population size put SRKWs at risk of infectious disease, we have not identified infectious disease as a limiting factor for the DPS. Diseases in natural populations can be difficult to study, particularly in marine mammals where relying on visual indicators can be challenging. Studies of dead or stranded animals provide critical post-hoc information on disease or infection status and underlie the need for real-time monitoring of SRKW health; however, opportunities to examine dead or stranded animals are limited. Gaydos et al. (2004) reviewed potential infectious disease threats for SRKWs. Recent efforts to characterize microbial composition in healthy individuals have provided important baseline data on commensal microorganisms to better understand killer whale host skin and respiratory physiology. For example, Hooper et al. (2018) utilized killer whale skin biopsies (collected for other studies) to characterize the skin microbiome and found stable differences across killer whale ecotypes and latitudes, including North Pacific Residents. The presence of a diatom was tentatively linked to poor skin condition, though presence was low in North Pacific killer whales.

Respiratory tract samples can be collected non-invasively from the exhaled plume of cetaceans when they surface to breathe. The exhaled breath includes moisture and small amounts of lung surfactant containing microorganisms inhabiting the respiratory tract. This respiratory microbiome can be analyzed by culture-based methods and genetic sequencing to identify the microbiota found in the respiratory system. In a recent study, 26 exhaled breath samples were analyzed using culture-based methods, including 12 identified to be from SRKWs (Raverty et al. 2017). While the microbiota consisted primarily of commensal bacteria and fungi, some potentially pathogenic bacteria were also detected, including a known pathogenic species of *Salmonella* (Raverty et al. 2017). The microbial composition of the exhaled breath was different from matched seawater samples collected from the sea surface microlayer (SML), indicating exhaled breath samples were not simply atomized seawater. Antibiotic-resistant bacteria, including multidrug resistance, were found in both exhaled breath and the SML, implicating human waste sources in the marine environment and highlighting the strong combined effects of the threats discussed in Factor A.

Additional sources of non-invasive samples have been and continue to be evaluated for health information, including expelled mucus, fecal material, and skin from DTAG suction cups. Characterization from SRKW mucus samples collected from 2009 through 2019 provided an initial baseline for bacterial communities from upper respiratory and oral tracts (L. Rhodes, pers. comm.), and genetic identification of source will allow a time-series assessment for individual animals. Fecal material has revealed *Anisakis* spp. are common

(marine mammals are definitive hosts for this parasitic nematode), and potentially pathogenic *Salmonella* spp. occur at low prevalence (~ 6%, L. Rhodes, pers. comm.). These non-invasive samples are promising sources of health information, and they continue to be under investigation.

Though these studies provide a mechanism for monitoring and a baseline for comparison across individuals and over time, we still do not have sufficient information on how other threats, such as contaminants and prey availability, impact the susceptibility of SRKWs to disease. Certain contaminants may have negative consequences for the immune system; however, no direct observations or measurements have been made in killer whales to support this theory. Moving forward, regular monitoring efforts combined with opportunistic non-invasive sampling may be needed to understand real-time disease susceptibility and to identify infection when it occurs.

New, emerging diseases or pathogens may be an additional threat to populations already under pressure. For example, mucormycosis is a disease caused by a fungal pathogen first observed in the Pacific Northwest in 2012 in a dead stranded harbor porpoise (Huggins et al. 2020). Since 2012, the fungus has been detected in 21 marine mammals along the Pacific coast of North America, and has been implicated in the death of one SRKW (Huggins et al. 2020). Regular monitoring efforts in all marine mammals will enable early detection and response to emerging pathogens. Additionally, results from the killer whale genome study may provide insight into health and immune function.

Factor D: The inadequacy of existing regulatory mechanisms
Objective: Ensure that regulatory mechanisms other than the ESA are adequate to ensure that threats to the sustainability of the DPS do not recur.

Criteria:

D1. Baseline conditions of emerging contaminants, such as PBDEs, in Southern Residents, prey species, and surrogate marine mammal populations in the greater Puget Sound area have been determined, and trends and other information indicate that contaminant inputs into the Southern Residents' habitat are not limiting recovery and sustainability of Southern Residents.

D2. Regulations are in place to limit the introduction of harmful contaminants, and there is evidence of decreasing levels of contaminants detected in Southern Residents, prey species, or surrogate marine mammal populations, or evidence that the current level of contaminants causes no harm to the whales.

D3. There is a reduction in impacts from commercial and recreational whale watching, or evidence that this activity does not cause population level effects. Reductions may be measured through fewer incidents reported in the vicinity of whales, increased audiences for education programs, and establishing regulations/protected areas if needed (see Criterion A4).

Have the Threats Criteria for Factor D been met?

No, the threats criteria for Factor D have not been met. Additional information is necessary to evaluate the adequacy of existing regulatory mechanisms, particularly to address pollution and contaminants. NMFS has made progress in addressing impacts from vessels by developing regulations to reduce disturbance. Similar to Factor A, under Factor D and as described in our analysis of the recovery criteria below, existing regulatory mechanisms regarding contaminants and vessel disturbance continue to present a high threat to the survival and recovery of SRKWs. The high likelihood and severity of contaminant and vessel disturbance threats under Factor D remain similar (see Table 2.1), and likely work in concert to present a high threat to the survival and recovery of SRKWs and continued danger of extinction.

D1. We do not currently have sufficient baseline or trend information to evaluate if contaminant loads and accompanying physiological impacts are limiting the recovery and sustainability of SRKWs. As described above under A3, there is some information on trends and levels of contaminants in killer whales and other marine mammals; however, many of the contaminant studies on killer whales rely on small sample sizes. Consequently, additional monitoring is needed to track trends in individual animals over time and to determine the specific physiological effects of contaminant exposure in SRKWs.

D2. To address the threat of pollution and contamination, NMFS participated in efforts of the PSP to develop a strategy for cleaning up, restoring, and protecting Puget Sound by 2020. As described in Section 2.3, the 2020 goal for killer whales has not been met. Although high levels of persistent organic pollutants remain in the marine environment, one recent study suggests that PCB levels may be declining in some marine mammals (Ross et al. 2013). See A3 above and in the downlisting criteria (Section 3.4.2) for information on efforts to assess contaminant trends and our need for additional information on potential harm from contaminant exposure.

D3. See A4 and B1 of the delisting criteria for information on actions to reduce disturbance by vessels, including commercial and recreational whale watching, recent trends, and efforts to track compliance.

Factor E: Other natural or manmade factors affecting its continued existence.
Objective: Maintain protection from oil spills and improve oil spill response techniques for killer whales. Continue monitoring the population and identify any new natural or manmade factors affecting the recovery of Southern Residents.

Criteria:
E1. Effective oil spill response plan is in place for killer whales as part of the wildlife branch section of the NWACP.

E2. Effective oil spill prevention plans are in place that are no less protective than those in place at time of listing.

E3. An annual census is in place which has and will continue to assess the population status of Southern Residents.

E4. Knowledge of distribution, habitat use and potential risks to the population in the coastal portion of the range of Southern Residents has been increased and determined not to affect the sustainability of the population.

Have the Threats Criteria for Factor E been met?

Not all of the threats criteria for Factor E have been met. NMFS, along with partners, has made significant progress by developing an oil spill response plan and supporting the annual census. The designation of coastal critical habitat was informed by new information on the distribution and habitat use of the whales and current efforts are ongoing to evaluate and mitigate risks to SRKW in the coastal portion of their range. Despite this progress, under Factor E and based on our analysis below of the recovery criteria below, SRKWs still face risk from oil spills, and we have insufficient information to evaluate the full range of risks to SRKWs in their costal habitat. Medium to high severity and low to high likelihood of threats from oil spills under Factor E remain similar, depending on the type of spill (see Table 2.1), present a moderate to high threat to the survival and recovery of SRKWs, and contribute to continued danger of extinction.

E1. As described in Section 2.3, NMFS has worked closely with partners to address the threat of an oil spill in SRKW habitat by developing a killer whale-specific oil spill response plan, which has been incorporated into the NWACP (https://www.rrt10nwac.com/nwacp/). It has also developed a hazing implementation plan to deter killer whales from entering spilled oil (https://media.fisheries.noaa.gov/dam-migration/srkw_oilspill_hazing-imp-plan_2014update.pdf).

E2. NMFS is not aware of any reduction in oil spill prevention practices and continues to track state-wide initiatives to reduce oil spill risk further. In 2019, the Washington Department of Ecology released their *Report of Vessel Traffic and Vessel Traffic Safety* for the Strait of Juan de Fuca and Puget Sound Area, with vessel management and safety recommendations, as part of the Strengthening Oil Transportation Safety Act (E2SSB 6269) passed by the Washington State Legislature in 2018. The report can be found at https://apps.ecology.wa.gov/publications/SummaryPages/1908002.html. As described in Section 2.3, the Washington State Legislature amended RCW 88.16.190 in 2019, requiring tug escorts for smaller oil vessels to align with larger oil vessel requirements (ESHB 1578).

A summary report of Washington State legislation that reduces threats to SRKWs can be found at https://apps.ecology.wa.gov/publications/documents/1908012.pdf. For additional information and links to reports on capacity to respond to oil spills in Washington, and oil spill prevention, preparedness and response, please visit https://ecology.wa.gov/Spills-Cleanup/Spills and http://www.psp.wa.gov/oilspills.php.

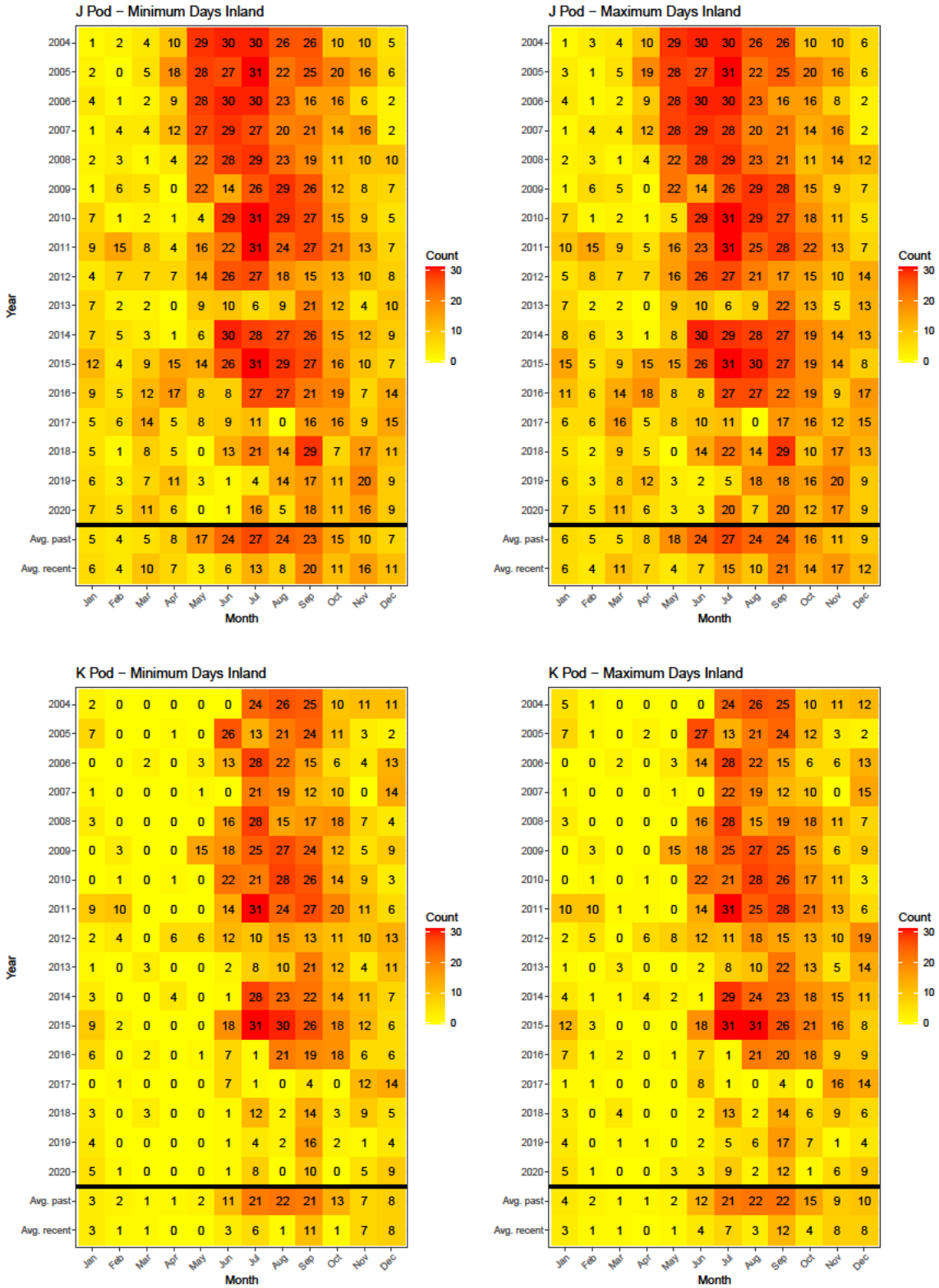
E3. The annual census conducted by the Center of Whale Research (www.whaleresearch.com) remains in place to assess the status of the SRKW population. NMFS has identified the census as a priority, provides support for the census, and expects these efforts to continue. NMFS' support for the Center for Whale Research annual census implements action A.1, Continue the annual census, from the Recovery Plan, and cost information for this action is included in Appendix A, Task A.1.

E4. SRKWs spend more than half of their time in coastal waters of the outer coast, primarily in winter months. Learning more about how they are using this habitat has been a top priority since their 2005 listing when only a handful of coastal sightings existed. The NWFSC and other partners have used several methods to gather new information about the whales along the coast. Sighting networks, such as Orca Network (http://www.orcanetwork.org/), encourage people to report sightings of the whales. Hydrophone networks, such as the SeaSound Project (http://www.orcasound.net/), and passive acoustic recorders deployed by scientists, collect vocalizations of the whales (Hanson et al. 2013; Riera et al. 2019; Emmons et al. 2021; Rice et al. 2021). In addition to opportunistic sightings and acoustic recordings, researchers use information collected from satellite tags to track individual SRKW movements. Between 2012 and 2016, the NWFSC deployed eight satellite tags to track SRKWs during the winter months when they leave Puget Sound. The tracking was a collaborative effort between NWFSC, Cascadia Research Collective, and the University of Alaska with funding support from the U.S. Navy. 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.

The tagging data provided insight into the seasonal home range of each pod and how they overlap, including what areas were used more frequently than others. 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, Oregon, and California during winter months, and in particular frequented the area between Gray Harbor and the Columbia River (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. Almost all (96.5%) outer coastal locations of satellite-tagged SRKWs occurred in continental shelf waters of 200 m depth or less (Hanson et al. 2017). Additionally, almost all (95%) of the locations were within 34 km of shore (in another study, 83% of passive acoustic detections were at nearshore sites; Emmons et al. 2021). Similar to inland waters, the timing and duration of use in these areas appears to coincide with seasonal returns of salmonids, particularly Chinook (Ford 2006; Ford et al. 2010; Hanson et al. 2010; Ford et al. 2017; Hanson et al. 2021).

In the last five years, SRKWs have been spending fewer days in inland waters compared to earlier years, though there are differences among pods and large inter-annual variability. SRKWs continue to be sighted most frequently along the west side of San Juan Island during the summer months, but with later arrival dates in the Salish Sea and fewer days spent inland in the last several years (NMFS 2021a, and Figure 3.3 below). Additionally, a recent study found that SRKWs have spent, on average, fewer days in the Salish Sea during the spring (April-June) season since 2005, possibly corresponding to a reduction in Fraser River spring run Chinook salmon (Shields et al. 2019).


J Pod – Minimum Days Inland
J Pod – Maximum Days Inland
K Pod – Minimum Days Inland
K Pod – Maximum Days Inland
Year
Month
Count
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Avg. past
Avg. recent

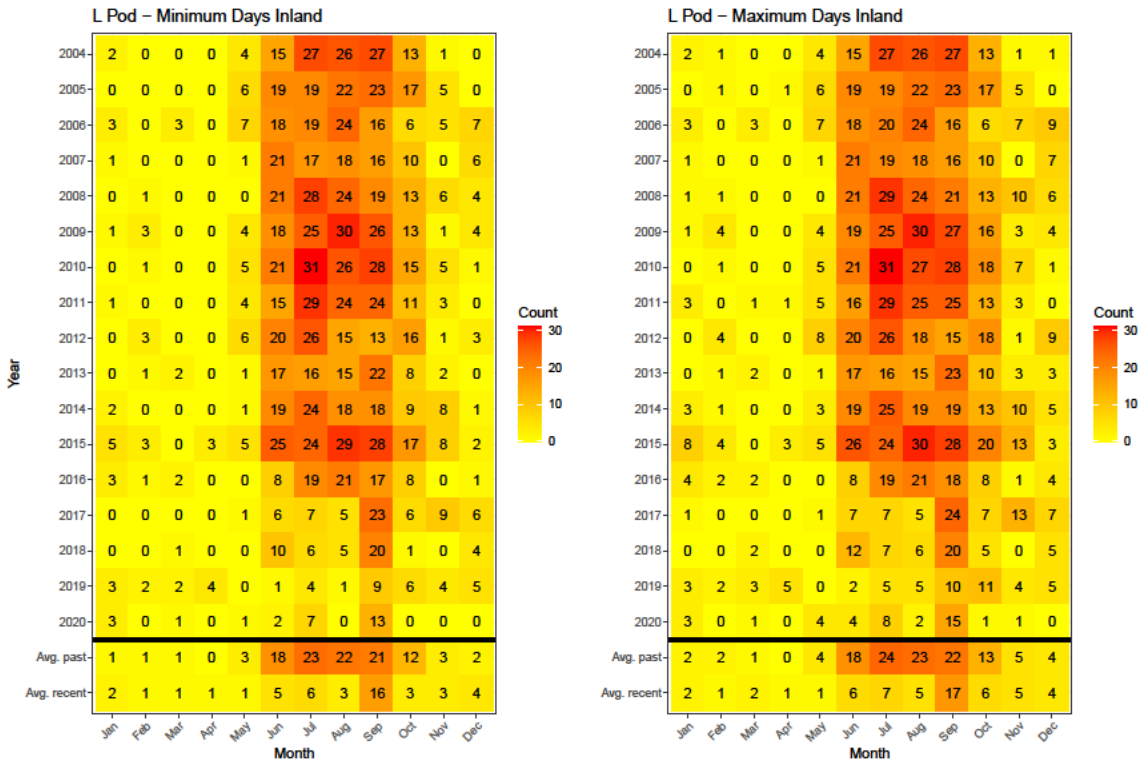


Figure 3.3. Minimum and maximum number of days that each SRKW pod (J, K, or L) was present in inland waters of the Salish Sea by year and month based on opportunistic sightings (Whale Museum, unpubl. data) (updated figure from NMFS 2021a). "Avg past" is the average before 2017 and "Avg recent" is the average from 2017-2020. Minimum Days Inland includes only sightings where pod was specified and known with certainty. Maximum Days Inland include sightings where pod was specified, including when there was uncertainty, and also includes counts of sightings of SRKWs (without pod specified) if no specific pod was listed as sighted any time that day. The area of the Salish Sea included in this figure encompasses both U.S. and Canadian waters, including the quadrants defined by The Whale Museum (see Figure 1 in (Olson et al. 2018)) and extending further west into the Strait of Juan de Fuca to the edge of SRKW critical habitat at Cape Flattery.

In 2014 NMFS received a petition requesting an expansion of critical habitat from the existing approximately 2,560 square miles designated in inland waters of Washington (71 Fed. Reg. 69054; November 29, 2006) to include offshore waters of the Pacific Ocean. NMFS accepted the petition and identified the next steps for modifying the critical habitat in our 12-month finding (80 Fed. Reg. 9682, February 24, 2015). In 2019, NMFS published a proposed rule and request for public comments (84 Fed. Reg. 49214, September 19, 2019) on the proposed revision to SRKW critical habitat to designate six additional coastal critical habitat areas (approximately 15,910 sq. miles). Each coastal area contains all three physical or biological essential features identified in the 2006 designation: (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. The final rule, published in 2021 (86 Fed. Reg. 41668, August 2, 2021), became effective on September 1, 2021. A complete summary of actions for critical habitat designations for SRKWs, including links to the 2019 proposed revision and 2021 final rule, Final Biological

Report, Economic Report, and ESA 4(b)(2) Report, and detailed maps of the revised critical habitat, can be found at https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/critical-habitat-southern-resident-killer-whales.

Further, Amendment 21 to the PFMC ocean salmon Fisheries Management Plan (86 Fed. Reg. 29544, June 2, 2021; also see Sections 2.2 and A.2 in the delisting criteria) includes measures to address prey-related needs of SRKWs in the coastal portion of their range.

3.4 Downlisting Criteria

3.4.1 Biological Criteria

Criteria:

1. The Southern Resident DPS has exhibited an increasing population trend at an average growth rate of 2.3 percent per year for 14 years (one cycle).

2. Available information on social structure and population structure are consistent with the trend observed under Criterion 1 above, and they are indicative of an increasing or stable population.

Quantitative measures for some population parameters:

- Representation from at least three pods, and
- At least two reproductive age males in each pod.

Have the Biological Downlisting Criteria been met?
No, not all of the biological downlisting criteria have been met.

1. As discussed in Section 3.3.1, only 73 individuals currently exist in the population, down from 88 individuals in 2007. The DPS has decreased in size over the last 14 years.

2. As discussed in Section 3.3.1, there is representation in all three pods, J (24 whales), K (16 whales), and L (33 whales) (CWR 2021). At the time of this review, there were 6 reproductive age males in J, 8 in K, and 12 in L pod. The current population demographics by age-sex class are shown in Table 3.2. Though the quantitative measures regarding representation from all three pods and at least two reproductive age males in each pod have been met for Criterion 2, they do not indicate an increasing or stable population.

3.4.2 Threats Criteria and ESA 4(a)(1) Analysis

The threats criteria are designed to evaluate the ESA section 4(a)(1) listing factors as they relate to the Southern Resident DPS. As identified above under 3.2.2.2, the recovery criteria address all current threats to the species, address all five of the listing factors, and describe their relevance to the species.

Factor A: The present or threatened destruction, modification, or curtailment of a species' habitat or range.

Objective: Ensure adequate habitat to support a recovering population of Southern Resident killer whales. Habitat needs include sufficient quantity, quality, and accessibility of prey species.

Criteria:

A1. Recovery or management plans for listed salmonids (and other prey species as appropriate) are in place to restore them to the point that they are self-sustaining members of their ecosystems.

A2. Research is underway to increase knowledge of the foraging ecology of Southern Residents and inform fishery management programs that determine harvest limits, hatchery practices, and evaluate consistency with recovery of salmon stocks and Southern Resident killer whales.

A3. Baseline information on legacy and emerging contaminant levels in killer whales, prey species, or surrogate marine mammal populations in the greater Puget Sound area is available to enable future monitoring of trends in contaminant levels in the whales and inputs into their habitat.

A4. Voluntary guidelines, education programs, and prohibitions under the MMPA to reduce vessel disturbance, auditory masking and risk of ship strikes, currently in place, should have remained in place.

Have the Threats Criteria for Factor A been met?

No, the threats criteria for Factor A have not been met; however, we have made progress on some threats. NMFS has completed recovery plans for ESA-listed salmon and steelhead. NMFS, along with other partners, have developed regulations and voluntary guidance to reduce vessel disturbance. Research is underway to learn more about foraging ecology, but there are still gaps in information needed to inform harvest, hatchery, and salmon recovery actions. We have baseline information for levels of some contaminants in Puget Sound, but the studies have small sample sizes, and mechanisms for regular monitoring are needed. Under Factor A and as described in our analysis of each downlisting recovery criteria related to Factor A below, effects to SRKW habitat and current levels of destruction and modification through prey availability, contaminant levels, and vessel disturbance pathways continue to pose a high risk to the whales. The high likelihood and severity of many of the threats under Factor A remain similar (see Table 2.1), and likely work in concert to present a high threat to the survival and recovery of SRKWs and continued danger of extinction.

A1. There are 28 ESA-listed Pacific salmon ESUs and steelhead DPSs in the West Coast region. Final recovery plans, which provide guidance on actions needed to restore the populations to become viable and functional elements of their ecosystems, are in place for all 28 listed salmonid populations. Five recovery plans were published since 2016, including (1) California Coastal Chinook Salmon, Northern California Steelhead, Central California Coast Steelhead, (2) Oregon Coast Coho, (3) Snake River Fall Chinook, (4) Snake River Spring/Summer Chinook, Snake River Basin Steelhead, and (5) Puget Sound Steelhead. Recovery implementation for salmon and steelhead include initiatives geared toward habitat restoration, hatchery programs, safe passage infrastructure, and reintroduction efforts. See

Section 2.3 for an overview of salmon recovery efforts, including the PCSRF, the 2019 PST agreement, and other regulatory actions. For a summary of Washington State efforts and progress on salmon recovery, please visit https://stateofsalmon.wa.gov/. For additional information on ESA-protected salmon and steelhead, please visit https://www.fisheries.noaa.gov/species/pacific-salmon-and-steelhead#esa-protected-species.

A2. Since the last 5-year review was conducted, significant progress has been made in understanding SRKW foraging ecology during the non-summer months and in outer coastal waters. As described in the A2 delisting criteria, a recent, comprehensive study characterized SRKW diet composition using prey remains and fecal samples during the non-summer months, including outer coastal waters, which previously had not been well-studied (Hanson et al. 2021). This research identified prey species composition, as well as genetic stock origin of Chinook salmon prey. Although diet diversity increases during the non-summer months, Chinook salmon remained an important component of the SRKW diet year-round. NMFS utilized these data and results in the 2018 Priority Chinook Stocks report to support salmon conservation efforts that directly benefit SRKWs, and will update this report as new data become available.

Despite considerable progress in understanding the SRKW diet, data gaps on the foraging ecology of the whales still exist. A lack of information on foraging efficiency, gut transit time, and how much prey are in the environment, or prey density, limit our understanding of what is needed to meet the energetic needs of the SRKW population. Additionally, we still lack an understanding of how whales assess prey within the environment, possibly affecting speed and duration of time spent in an area. Some studies have noted that the presence of surface-active behaviors correlates with salmon abundance (Bubac et al. 2020; Jensen et al. 2020), suggesting that there may be both foraging and social functions to these behaviors. Addressing these key information gaps would help to better parameterize models of existing prey availability and to estimate future prey needs. It is also still unclear which specific geographic areas or times of year the whales may be prey limited. At this time, NMFS has not conducted an analysis to determine if salmon recovery goals are sufficient to support a recovered SRKW population. Appendix A includes information on NMFS funding for research actions in the Recovery Plan, including action B.2, Investigate the diet of the Southern Residents.

A3. Research on the effects of environmental contaminants on SRKWs began in the early 1990s. It has been widely known that POPs or "legacy contaminants" are of particular concern to the whales. High concentrations of POPs have been linked to endocrine, metabolic, and immune disruption, cancer, decreased reproduction, and increased calf mortality (Reijnders 1986; de Swart et al. 1996; Schwacke et al. 2002; Ylitalo et al. 2005; Buckman et al. 2011; Gockel & Mongillo 2013; Lundin et al. 2016; Mongillo et al. 2016; Hall et al. 2018). Furthermore, chemical byproducts or metabolites of POPs are also worth studying, as they may further increase toxicity or result in their own impacts not otherwise identified (Mongillo et al. 2016).

POPs are highly lipophilic and persist in blubber tissues in marine mammals. A recent study quantified POP concentrations in paired blood and blubber samples from two individuals and

found positive correlations, confirming that blubber biopsy measurements reflect circulating contaminant profiles (McCormley et al. 2021). These findings will enable greater confidence in contaminant load measurements when sample types may be limited.

Whales are exposed to POPs from early in life through nursing and via consumption of contaminated prey throughout their lifetime. When adult females lactate, they offload contaminants stored in their blubber by metabolizing blubber lipids to produce milk which transports those contaminants to the offspring. In a recent study on a captive killer whale mother and her first born calf, milk produced early in the lactation period had the highest POP concentrations. Milk and maternal POP concentrations declined over the next ~5 months before leveling off for the remainder of the lactation period (Noren et al. 2018). POP concentrations in the calf also reflected high contaminant transfer through milk. At the end of the lactation period, the calf blood POP levels were 5-8 times higher than its mother's (Noren et al. 2018).

As mentioned previously, compounding effects of stressors are of concern in SRKWs. Reduced prey availability may exacerbate the effects of high contaminant levels, as the contaminants become mobilized in the bloodstream when stored fat is metabolized in the absence of food (see Lundin et al. 2016b). Relatively high levels of pollutants have been measured in blubber biopsy samples from SRKWs compared to other killer whales in the North Pacific (Ross et al. 2000; Krahn et al. 2007; Krahn et al. 2009; Alonso et al. 2014; Alava et al. 2016; Lawson et al. 2020) These high levels of pollutants highlight their vulnerability to the interacting impacts of contaminant exposure, low prey abundance, and other anthropogenic factors such as vessel disturbance that reduces their ability to locate prey.

In 2018, researchers quantified the concentration of polycyclic aromatic hydrocarbons (PAHs) found in killer whale fecal samples in an effort to establish baseline levels of the hazardous compound that is found in oil and vessel exhaust (Lundin et al. 2018). Whales can become exposed to PAHs through aerosol inhalation and contact or ingestion within the water column, with the greatest risk being after an oil spill or in close proximity to vessels (Lachmuth et al 2011). Over the four-year study, PAH levels were relatively low except for four outliers sampled in 2010 (Lundin et al. 2018), before the U.S. vessel distance regulations. However, the extent to which these individuals were exposed to vessels before sampling is unknown. Future work validating these results, and addressing field contamination issues, will support an established baseline understanding of PAH exposure and provide critical information on potential future oil spill cleanup efforts.

Microplastics (microplastic and microfiber particles) are increasingly recognized as a source of contamination in all marine organisms. For marine mammals, the potential exposure pathways include occasional direct incidental ingestion and, more commonly, indirect consumption of contaminated prey. Very little data exist on microplastics levels in SRKWs, though it is the subject of ongoing research in a collaboration among scientists at the NWFSC and the University of Washington. Preliminary data indicate detectable levels of microplastic particles and fibers in every examined killer whale fecal sample from both SRKWs (n = 18) and Alaska resident killer whales (n = 15) (K. Parsons, pers. comm.). The

microparticle burden (particles/g dry fecal matter) varied considerably among samples. While a recent paper modeling bioaccumulation and biomagnification using resident killer whales and Chinook salmon as a model predator-prey system suggested that the biomagnification of microplastics particles is low among fish-eating cetaceans (Alava 2020), the physiological and biological effects of microplastic ingestion and potential transfer of biotic and abiotic contaminants to higher trophic marine organisms is unknown.

Many of the contaminant studies on killer whales rely on small sample sizes. Regular systematic, non-invasive monitoring is needed to establish individual-level baseline exposure to contaminants, track trends in individual animals over time, and link physiological effects with different levels of the various contaminants discussed.

A4. As described under the A4 delisting criteria and Section 2.3, NMFS has taken several management actions to reduce vessel disturbance. Mandatory federal regulations were codified in 2011, with Washington State and Canadian regulations put in place and updated in recent years. A year-round voluntary No-Go zone has existed for many years on the west side of San Juan Island and is now compulsory for commercial whale watch operators. We have continued to work with our partners to promote voluntary guidelines (Be Whale Wise, Whale Warning Flag) and implement education programs. Previous guidelines and education programs have remained in place while some education programs have expanded. Two ESA Section 6 grants assist WDFW in their enforcement efforts, and Soundwatch has continued to receive funding for their education and outreach programs, as well as their on-the-water monitoring efforts. A summary of the effectiveness of the 2011 vessel regulations is described under D2 of the downlisting criteria. More information can be found at http://www.bewhalewise.org/.

Factor B: Overutilization for commercial, recreational, or educational purposes
Objective: Ensure commercial, recreational, or educational activities are not affecting the recovery of Southern Residents, including vessel effects from whale watching.

Criteria:
B1. No permanent removals of individual Southern Residents from their habitat, including live capture for public display, and there is sufficient information on any incidental takes associated with fisheries or other commercial or recreational activities to inform management programs responsible for addressing incidental takes.

Have the Threats Criteria for Factor B been met?
Yes. Under Factor B and as described in our analysis of the recovery criterion below, SRKWs face low risk from removals. However, the moderate to high likelihood and severity of overutilization through vessel impacts under Factor B remain similar (see Table 2.1 and Section 3.3.2 of the delisting criteria), present a moderate to high threat, and contribute to continued danger of extinction.

B1. As described under the B2 delisting criteria, the public display industry has not requested authorization to remove SRKWs from the wild, and NMFS has not authorized any live captures. Incidental take in fisheries is not currently a threat to SRKWs; however, some potentially harmful interactions do occur (Caretta et al. 2021; Balcomb 2015). NMFS will continue to rely on reports of any incidental take in fisheries from the fishing community and from observers to monitor any increase in takes. Efforts to reduce incidental impacts from large commercial vessels are described below under D.4. As described above under A.4, some voluntary programs have remained in place, while more protective measures to reduce vessel disturbance from commercial and recreational whale watching have also been implemented since the recovery plan was written.

Factor C: Disease or predation
Objective: Ensure that diseases and their effects on reproduction and survival are not a threat to the sustainability of the Southern Resident DPS.

Criteria:
C1. Sufficient knowledge to determine that disease is not limiting the recovery of Southern Resident killer whales.

Have the Threats Criteria for Factor C been met?
No, the threats criteria for Factor C have not been met. Additional information is needed to ensure that diseases are not affecting the reproduction and survival of Southern Residents. Under Factor C and as described in our analysis of the recovery criterion below, SRKWs still face unknown risks of disease or pathogens in the marine environment. While the severity of disease under Factor C remains potentially high, the likelihood continues to be low based on our ongoing monitoring (see Table 2.1). Disease presents a moderate threat to the survival and recovery of SRKWs.

C1. As described under the C1 delisting criteria, we have not identified infectious disease as a limiting factor for the SRKW population. We do not, however, have sufficient information to ensure that disease is not affecting the population. In a review of 70 stranded killer whales (all ecotypes) from 2001-2017, the cause of death was only determined for 38 individuals (Raverty et al. 2020). Of the 38 individuals, infectious disease was confirmed as a cause of death for only one SRKW out of the five total killer whales who died from disease (Raverty et al. 2020). Before 2001, only one additional SRKW for which cause of death was determined through necropsy died of infection – J18 was recovered in 2000 in Tsawwassen, Canada (D. Noren, pers. comm.). Additional monitoring of the population and thorough health sampling, visual health assessments, and examinations of any stranded killer whales are needed to increase our understanding of how diseases are affecting the SRKWs.

Factor D: The inadequacy of existing regulatory mechanisms
Objective: Ensure that regulatory mechanisms other than the ESA are adequate to ensure that no threats to the sustainability of the DPS recur.

Criteria:

D1. Regulations in place to limit the introduction of harmful contaminants are under evaluation to determine if they are sufficiently protective for Southern Residents.

D2. Guidelines and regulations in place to reduce potential impacts from vessels have been evaluated to determine if additional regulations/protected areas are needed (see Criterion A4).

Have the Threats Criteria for Factor D been met?

No, the threats criteria for Factor D have not been met. Additional information is necessary to evaluate the adequacy of existing regulatory mechanisms, particularly to address pollution and contaminants. NMFS has made progress in addressing impacts from vessels by developing regulations to reduce disturbance and has evaluated their effectiveness. Similar to Factor A, under Factor D and as described in our analysis of the recovery criteria below, existing regulatory mechanisms regarding contaminants and vessel disturbance continue to present a high threat to the survival and recovery of SRKWs. The high likelihood and severity of contaminant and vessel disturbance threats under Factor D remain similar (see Table 2.1), and likely work in concert to present a high threat to the survival and recovery of SRKWs and continued danger of extinction.

D1. Resulting from the Governor's Task Force recommendations of 2018, initiatives aimed at prioritizing chemicals for species recovery, cleaning up contaminants, and water quality enforcement have moved forward with partnerships across agencies, including Ecology. Through ESA consultations, NMFS will evaluate the effects of federal actions associated with regulations and standards for harmful contaminants on SRKWs, including a recent jeopardy determination for re-issuance of the EPA's Pesticide General Permit (NMFS 2021c).

D2. In the final rule implementing the 2011 federal vessel regulations, NMFS committed to (1) review the regulations to evaluate effectiveness, and (2) study the impact of the regulations on the viability of the local whale watch industry. Education, enforcement, and monitoring efforts were documented to support the review, and the results were analyzed and published in a 2017 NMFS Technical Memo (Ferrara et al. 2017). The 2017 analysis evaluated the effectiveness of the vessel regulations using five key measures: education and outreach efforts, enforcement, vessel compliance, biological effectiveness, and economic impacts. For each measure, the analysis focused on the five years leading up to the regulations (2006-2010) and compared trends and observations to the five years following their implementation (2011-2015). Ferrara et al. (2017) concluded that the regulations have provided some benefits to the whales; however, additional measures may be necessary to reduce the impacts of vessels on SRKWs. Although robust education and outreach efforts were in place in the years following the implementation of the regulations, awareness of the regulations among recreational boaters remained low, fluctuating around 45% of the boaters contacted by Soundwatch from 2011-2015. This was reflected in the compliance trends, which showed higher rates of incidents of noncompliance among recreational boaters than commercial whale watch operators. Despite this trend in awareness, compliance with the regulations in the five years following the codification of the regulations was significantly higher in the presence of enforcement vessels, indicating an effective enforcement program. Although

these regulations required commercial whale watch operators to change their behaviors around the whales, they did not result in adverse economic impacts to the industry from 2011 through 2015.

NMFS has used these conclusions to guide our participation in developing new measures at the state and international levels, including on the Governor's Task Force Vessel Working Group and in coordinating with DFO and Transport Canada in the development of measures in Canadian waters. Evaluation by Washington State and Canada regarding their recent protective measures for SRKWs is also underway. The ECHO program has focused on evaluating the effectiveness of their voluntary measures (i.e., slow-downs) (see A4 of the delisting criteria), which will help to inform the Quiet Sound program (see Section 2.3) moving forward. These findings and information from other evaluations will also inform NMFS evaluation of the need for updates to the U.S. federal regulations.

Factor E: Other natural or manmade factors affecting its continued existence
Objective: Maintain protection from oil spills and improve oil spill response techniques for killer whales. Continue monitoring the population and identify any new natural or manmade factors affecting the recovery of Southern Residents.

Criteria:
E1. Effective oil spill prevention plans are in place that are no less protective than those in place at time of listing.

E2. An annual census is in place which has and will continue to assess the population status of Southern Residents.

E3. An effective research program is in place to evaluate risks to Southern Resident killer whales.

E4. Research on the distribution, habitat use and potential risks to the population in the coastal portion of the range of Southern Residents is underway.

Have the Threats Criteria for Factor E been met?
Not all of the threats criteria for Factor E have been met. Federal, state, and industry oil spill prevention activities are ongoing. NMFS participates in an active research program with many partners and supports the annual census. Current efforts are underway to evaluate and mitigate risks to SRKWs in the coastal portion of their range. Despite this progress, under Factor E and based on our analysis below of the recovery criteria below, SRKWs still face risk from oil spills, and we have insufficient information to evaluate the full range of risks to SRKWs in their costal habitat. Medium to high severity and low to high likelihood of threats from oil spills under Factor E remain similar, depending on the type of spill (see Table 2.1), present a moderate to high threat to the survival and recovery of SRKWs, and contribute to continued danger of extinction.

E1. A description of ongoing oil spill prevention efforts can be found under the E2 delisting criteria.

E2. As described under the E3 delisting criteria, the annual census conducted by the Center for Whale Research is expected to continue. NMFS' support for the Center for Whale Research annual census implements action A.1 from the Recovery Plan: Continue the annual census. Cost information is included in Appendix A, Task A.1.

E3. NMFS is part of an active research program. Appendix A identifies NMFS support for research actions in the Recovery Plan, many of which are designed to assess the threats to the whales. Recent publications can be found in Section 4.1, as well as on the NWFSC website at https://www.fisheries.noaa.gov/resource/publication-database/northwest-fisheries-science-center-publications-database.

E4. The research programs underway to increase knowledge of coastal distribution and habitat use are described under E4 in the delisting criteria. Coastal acoustic monitoring is ongoing. The 2021 critical habitat revision (86 Fed. Reg. 41668, August 2, 2021)) utilized the latest science to determine SRKW distribution and habitat use in coastal areas. More detail can be found in the Final Biological Report at https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/critical-habitat-southern-resident-killer-whales.

4.0 RESULTS

4.1 Updated Information and Current Species Status

The 2008 Recovery Plan for Southern Resident Killer Whales includes comprehensive information on SRKW biology, habitat, and threats. This 5-year review and Center for Whale Research census (CWR 2021) for SRKWs contain updated information. New information, including research, population status updates, and recovery actions conducted over the last five years, are outlined above in Sections 3.3 and 3.4, which include progress on the biological recovery criteria and the threats recovery criteria (5-factor analysis). NMFS maintains an active research program, and researchers have completed many new papers since we completed the last 5-year review in 2016. These research papers, plus additional papers and reports related to the major threats, are identified in Appendix B, though this list is not meant to be comprehensive of all research done on killer whales worldwide. Recent biological opinions incorporate the latest information from these and other scientific papers and unpublished data. Overall, while this new information increases our knowledge of SRKW conditions and threats, it does not indicate a change the species' status or the magnitude or imminence of the threats since the listing.

4.2 Synthesis

SRKWs were listed as Endangered in 2005. In the 16 years since their listing, and the years before the listing, various federal, state, non-profit, and local organizations have implemented conservation actions to benefit the whales, their prey, and the ecosystem. The Recovery Plan (NMFS 2008a) was an important step in laying out a roadmap of

specific recovery actions and goals. While we have made some progress toward the goals in the plan, recovery of this population of long-lived, slow-reproducing killer whales is a long-term effort that requires cooperation and coordination of West Coast communities from California to British Columbia. While many key data gaps have been filled and protective actions are assessed on an ongoing basis, it remains challenging to link any specific action directly to population changes. Recovery of the ecosystem, food web, and the whales is a long-term effort. It will take many years to see the benefits of ongoing recovery actions for the whales, salmon, and their habitat, and to observe associated increases in the SRKW population.

NMFS, working with many partners, has made progress in filling data gaps. There is an active research program with new information and publications regularly available. In the last five years, significant advances have increased our understanding of coastal habitat use, diet during the non-summer months, and vessel impacts on behavior and foraging. Critically, ongoing monitoring projects allow for continued tracking of demographic shifts in the population. Researchers can now detect early body condition changes through regular aerial photographic monitoring. These ongoing research and monitoring programs are essential for informing management actions with the best available science. Despite significant advancements, many questions important to recovery remain unanswered. With SRKWs spending more time on the outer coast in recent years, more detail on each pod's movement and habitat use may inform adaptive management needs. More data on physiological, health, and reproductive impacts of contaminant exposure and pathogens is also needed to build a more complete picture of the cumulative threats faced by SRKWs. We must continue population assessments to evaluate the effectiveness of recovery actions.

Since completing the Recovery Plan, NMFS has prioritized actions to address the threats with the highest potential for mitigation: prey availability, contaminant exposure, and vessel impacts (Table 2.1). NMFS also recently completed a Species in the Spotlight Priority Action Plan for 2021-2025. Further, salmon recovery is a high priority on the West Coast, and there are numerous actions and funding initiatives underway to address threats and monitor populations. Recovery of depleted salmon populations is complex; implementing recovery plans and creating sustained population growth is a long-term process. The Governor's Task Force was a critical step in harnessing the power of collaborations and political will to develop specific actions that collectively should support the recovery of SRKWs. NMFS continues to work with state partners to implement recommendations from the Task Force. Despite significant progress in the last five years to minimize the impacts of the threats, each threat still poses a risk to the survival and recovery of the whales.

At the time of listing in 2005, the SRKW population included 88 whales. As of the official summer census in 2021, there were 74 whales in the population, with an additional whale (K21) presumed dead at the time of this report. Population growth has varied since listing, with both increasing and decreasing years, but the whales are currently experiencing a downward trend. The biological downlisting and delisting

criteria, including sustained growth over 14 and 28 years, respectively, have not been met.

While some of the biological downlisting and delisting criteria have been met, including some that were met before the listing and Recovery Plan (i.e., representation in all three pods, multiple mature males in each pod), the overall status of the population is not consistent with a healthy, recovered population.

Many recovery actions have been implemented and progress has been made to understand and reduce the risks of some threats. Despite this, the population has continued to decline, the biological criteria have not been met, and uncertainties about how threats are impacting survival and reproduction remain. The destruction or modification of the whales' habitat (and, to a lesser extent, their overutilization for commercial and recreational purposes and threats from other factors) through disturbance from vessels, the persistence toxins and emerging health concerns, and the potential limits on prey availability (primarily Chinook salmon), puts them in danger of extinction. The individual and cumulative effects of the threats, as described in our analyses of ESA section 4(a)(1) listing factors and the recovery criteria, remain high and are pronounced, particularly in light of the small size of the population and continued declines. Considering the status and continuing threats, the SRKWs remain in danger of extinction. Therefore, the recommended classification for SRKWs is to remain Endangered.

4.2.1 Recommended Classification

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (Indicate reasons for delisting per 50 CFR 424.11):
____ *Extinction*
____ *Species does not meet the definition of an endangered or threatened species*
____ *Listed entity does not meet the definition of a species*
__X__ No change is needed

4.2.2 New Recovery Priority Number: No change

5.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Recovery of SRKWs depends upon the implementation of a variety of actions detailed in the Recovery Plan and the full participation and support of all federal, state, and private stakeholders. These actions should be pursued aggressively to prevent the extinction of this DPS. Funding decisions should also aim to prevent the species' extinction and give highest priority to actions that will contribute directly to mitigating impacts and research that will inform management and conservation.

The Recovery Plan assigns priority categories 1-3 for activities related to recovery, research, and monitoring. Priority 1 actions are those that must be taken to identify the actions necessary to prevent extinction. We have assigned Priority 1 to research actions addressing each of the main threats: prey, contamination, and vessels and sound.

In the next five years, particular emphasis should focus on the following management and research actions:

- Protect SRKWs from harmful vessel impacts through enforcement, education, and evaluation.
- Target conservation of critical prey.
- Improve our knowledge of SRKW health to advance recovery and support emergency response.
- Raise awareness about the recovery needs of SRKW and inspire stewardship through education and outreach.

Specific research priorities, current projects, and some unfunded needs are highlighted in the Species in the Spotlight Priority Action Plan for 2021-2025.

NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW RECOMMENDATION
Southern Resident Killer Whales *(Orcinus orca)*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X__ No change needed

Review Conducted By: National Marine Fisheries Service
West Coast Regional Office

REGIONAL OFFICE APPROVAL:

West Coast Regional Administrator, National Marine Fisheries Service

Approve _____ Date December 20, 2021

HEADQUARTERS APPROVAL:

Assistant Administrator, NOAA Fisheries

I concur RAUCH.SAMUEL.D.III.1365850948 Digitally signed by RAUCH.SAMUEL.D.III.1365850948 Date: 2021.12.28 10:30:25 -05'00' Date _____
Signature

I do not concur_____Date_____

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APPENDIX A

Updated Implementation Schedule from the Recovery Plan for Southern Resident Killer Whales (NMFS 2008a). Implementation Schedule. Costs for FY2017-2021 provide information on conservation and research actions that have been implemented. Most costs represent NMFS funding, although salary costs for NMFS staff are not included. There are many ongoing programs in place that benefit SRKW, but would be carried out regardless of the status of killer whales. Where information is available on beneficial NMFS and partner programs we have included some general descriptions of expenditures, however, those costs are not included in the FY or overall totals.

RECOVERY MEASURES AND COSTS ($ Thousands)

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
1	**Protect Southern Resident killer whales from factors causing decline**			The NFWF Killer Whale Research and Conservation grant program (see Section 2.1) has contributed over $4.4 million in grant awards to support research and recovery of Southern Residents, with an additional $8.3 million in grantee match contributions. NMFS is a contributor to this fund along with SeaWorld, Shell, and the USFWS.					
1.1	Rebuild depleted populations of salmon and other prey to ensure an adequate food base for recovery of the Southern Residents			Under the 2019 PST agreement, the Hatchery Production Initiative provides at least $5.6 million per year to supplement SRKW prey abundance in Puget Sound and coastal waters. Additionally, in FY20-21 $10.4 million was dedicated towards habitat restoration for Puget Sound Chinook (NMFS 2021a). Many salmon recovery efforts and management programs are currently ongoing by a variety of agencies and stakeholders. Therefore, we have not identified all salmon restoration costs related to the recovery needs of SRKWs, and we do not have sufficient information to estimate those potential costs or identify the actions under which they would fall.					
1.1.1	Support salmon restoration efforts in the region			See 1.1					
1.1.1.1	Habitat management	2	NMFS, state/tribal/ local recovery initiatives, NGO, DFO	See 1.1					

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
1.1.1.2	Harvest management	2	NMFS, state/tribal/ local recovery initiatives, NGO, DFO	See 1.1					
1.1.1.3	Hatchery management	2	NMFS, state/tribal/ local recovery initiatives, NGO, DFO	See 1.1					
1.1.2	Support regional restoration efforts for other prey species	3	NMFS, state/tribal/ local recovery initiatives, NGO, DFO	See 1.1					
1.1.3	Use NMFS' authorities under the ESA and the MSFCMA to protect prey habitat, regulate harvest, and operate salmon hatcheries	2	NMFS	See 1.1					
1.2	Minimize pollution and chemical contamination in Southern Resident habitats			Many pollution control and site cleanup efforts are currently ongoing with support from a variety of agencies and stakeholders. The WA State Legislature enacted $186 million in 2019-2021 towards contaminant mitigation efforts that will support SRKW recovery following from the Governor's Task Force recommendations.					
1.2.1	Clean up contaminated sites and sediments			See 1.2					

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
1.2.1.1	Identify and prioritize specific sites in need of cleanup	2	CTC, NMFS, EC, DFO, EPA, WDOE, WDNR						
1.2.1.2	Remediate sites in need of cleanup	1	EPA, WDNR, potentially responsible/ liable parties, Superfund sites, See Appendix C	See 1.2					
1.2.2	Minimize continuing inputs of contaminants into the environment			See 1.2					
1.2.2.1	Minimize the levels of harmful contaminants discharged by industrial, municipal, and other point sources of pollution	3	WDOE, EPA, ODEQ, DFO, local/ municipal/ provincial	See 1.2					
1.2.2.2	Minimize the levels of harmful contaminants released by non-point sources of pollution	2	WDOE, EPA, ODEQ, DFO, local/ municipal/ provincial	See 1.2					
1.2.2.3	Reduce impacts to Southern Resident killer whales from emerging contaminants	3	WDOE, EPA, EC, local/ municipal	See 1.2					
1.2.3	Minimize contamination in prey	3	WDFW, ODFW, NMFS, USFWS, tribes, DFO	See 1.2					
1.3	Minimize disturbance of Southern Resident killer whales from vessels								

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
1.3.1	Monitor vessel activity around whales								
1.3.1.1	Expand efforts to monitor commercial and recreational whale-watching vessels	2	Soundwatch, M3, NMFS	Ongoing, see also B.6.2.2	53.1	50	125	125	90
1.3.1.2	Evaluate the relative importance of shipping, ferry, fishing, research, military, and other vessel traffic to disturbance of killer whales	3	NMFS, CTC, USCG, US Navy, industry associations	Initial report completed with FY06 funds; 1 year task to update report					25
1.3.2	Continue to evaluate and improve voluntary whale-watching guidelines	2	NMFS, M3, Soundwatch, DFO, NGO, WWOANW	Update guidelines in alternate years					
1.3.3	Evaluate the need to establish regulations regarding vessel activity in the vicinity of killer whales	2	NMFS, DFO, USCG, WDFW, tribes, industry associations	2 year task coordinated with 1.3.4				26.7	70.6
1.3.4	Evaluate the need to establish areas with restrictions on vessel traffic or closures to vessel traffic	2	NMFS, DFO, USCG, WDFW, tribes, industry associations	2 year task coordinated with 1.3.3					

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
2	**Protect Southern Resident killer whales from additional threats that may cause disturbance, injury, or mortality, or impact habitat**								
2.1	Minimize the risk of large oil spills								
2.1.1	Prevent oil spills	1	USCG, WDOE, EC, industry associations	The WA State Legislature enacted $1.3 million in 2019-2021 towards oil spill efforts that will support SRKW recovery following from the Governor's Task Force recommendations.					
2.1.2	Prepare for and respond to oil spills to minimize their effects on Southern Resident killer whales	1	NMFS, USCG, WDOE, WDFW, NW Contingency Plan Wildlife Section Working Group, industry associations	One year task to develop Contingen-cy Plan and training in alternate years, FY is TBD					
2.1.3	Develop strategies to deter killer whales from entering spilled oil	2	NMFS, WDFW	One year project					
2.2	Monitor and minimize the risk of disease pathogens in Southern Resident habitats			Part of stranding response, see 4					

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
2.3	Continue to use agency coordination and established MMPA mechanisms to minimize any potential impacts from human activities involving acoustic sources, including Navy tactical sonar, seismic exploration, in-water construction, and other sources	2	NMFS	Ongoing actions include Section 7 consulta-tions; no additional costs specific to killer whale listing or recovery currently identified					
2.4	Reduce the impacts of invasive species in Southern Resident habitats								
2.4.1	Prevent the introduction and spread of invasive species	3	WDFW, USFWS, NMFS, USCG, WDOA, ODEQ, DFO, industry associations	The Washington State Invasive Species Council (WISC) provides policy-level direction, planning, and coordination for statewide invasive species priorities. Visit https://invasivespecies.wa.gov/ for more information and the statewide invasive species strategy. In FY17-21, over $5 million was spent on aquatic invasive species prevention (reporting agencies include WISC, WDFW, including some funds from Washington Sea Grant and USFWS), and over $19 million was spent on aquatic invasive species eradication (reporting agencies include WDOA, WDNR, WDFW, and the Salmon Recovery Funding Board).					
2.4.2	Eradicate existing populations of invasive species	3	WDFW, USFWS, NMFS, WDOA, ODEQ, DFO, industry associations						

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
3	**Develop public information and education programs**								
3.1	Enhance public awareness of Southern Resident status and threats								
3.1.1	Exhibits at local museums, aquaria, parks, and other locations	3	SA, TWM, WSP, VA, Tribes, NMFS, Killer Whale Tales		50	50	50	50	50
3.1.2	School programs	3	NGO, Tribes		25	25	25	25	25
3.1.3	Naturalist programs	3	NGO, TWM						
3.1.4	Research programs	3	NWFSC, CWR, DFO and other researchers	Periodic research conferences, costs included under B.11					
3.2	Expand information and education programs to reduce direct vessel interactions with Southern Resident killer whales								

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
3.2.1	Expand the on-water educational efforts of Soundwatch, M3, and enforcement agencies	2	NMFS, Sound-watch, M3, WDFW, DFO	NMFS costs are included here and do not include JEA funds, additional costs are in 1.3.1.1					
3.2.2	Outreach to private boaters	3	NMFS, Sound-watch, M3, WDFW, DFO, CG	Costs are included under 1.3.1.1	1.8	1.8	1.8	1.8	2
3.2.3	Encourage land-based viewing of killer whales	3	TWM, Orca Relief, Lifeforce, WSP, NGO	Update program in alternate years, Whale Trail program	10	10	10	15	
3.3	Educate public on positive actions they can take to improve the current condition for Southern Resident killer whales	2	NGO, NMFS	Some costs included under 3.1					23
3.4	Solicit the public's assistance in finding killer whales								
3.4.1	Solicit reports of killer whale sightings	3	NMFS, TWM, OrcaNetwork, CWR, BC Sighting Network	Costs included under B1.1					25

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
3.4.2	Solicit reports of killer whale strandings from the public	3	NMFS, NMMSN, OrcaNetwork, CWR, BC Sighting Network	Education and outreach for NWMMSN program					
4	**Respond to killer whales that are stranded, sick, injured, isolated, pose a threat to the public, or exhibit nuisance behaviors**			Killer whale strandings are rare events and the cost of stranding response varies greatly depending on situation, location, local capabilities, status and number of whales. The West Coast Marine Mammal Stranding Network is involved in ongoing stranding response and the Prescott Grant program has been instrumental in increasing response capabilities for all strandings, including killer whales. A total of $2.2 million was awarded during FY17-FY20 to agencies in WA and OR. Additional Prescott funds to CA could also support killer whale stranding efforts, and NMFS contracted with UC Davis in FY16-FY17 for to assist with any killer whale stranding along the west coast (4.2.3).					
4.1	Manage atypical individual Southern Residents	3	NMFS, WDFW, DFO	Dependent on severity of situation, costs could range $100k-500k based on past atypical cases.					
4.2	Respond to strandings of killer whales			See Task 4					
4.2.1	Develop protocols for responding to stranded killer whales	3	NMFS, NMMSN, DFO, VA	Action completed					
4.2.2	Respond to live-stranded killer whales	2	NMFS, NMMSN, DFO, VA	See Task 4		8.2			

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
4.2.3	Investigate strandings of dead killer whales	3	NMFS, NMMSN, DFO, VA	Cost for response to stranded killer whales in OR, CA	18.6				
4.3	Respond to future resource conflicts between the Southern Residents and humans	3	NMFS, others as identified	As identified in the future					
5	**Trans-boundary and interagency coordination and cooperation**								
5.1	Cooperative research and monitoring	3	NMFS, DFO, WDFW, researchers	Future costs included under B.11					
5.1.1	Population monitoring	3	NMFS, DFO, WDFW, CWR	Costs included under A.1					
5.1.2	Stranding response coordination	3	NMFS, DFO, WDFW	Costs estimated as < 1K per stranding event, see 4					
5.2	Complimentary conservation and recovery planning			No costs identified at this time					
5.2.1	Plans are subject to periodic review	3	NMFS, DFO, WDFW	1 year task to update plan					

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
5.2.2	Encourage public participation	3	NMFS, DFO, WDFW	1 year task to update plan					
5.3	Inter-jurisdictional enforcement cooperation and coordination	3	NMFS, DFO, WDFW	NMFS funds proposals from state agencies to aid in recovery efforts of ESA-listed species. For FY17-FY21, NMFS has provided over $1.3 million to WDFW to support their efforts in enforcement, compliance, and public awareness of federal and state regulations in Puget Sound to minimize disturbance to Southern Resident killer whales.					
				TOTAL BY FY	158.5	145	211.8	243.5	310.6
				TOTAL[3]	**$1,099.6**				

[3]Throughout the table, costs for specific actions and years are rounded down to the nearest hundred, which were summed for annual FY totals. The final total dollar amount for all Recovery Measure costs reflects the actual amount spent in FY17-21 and therefore does not equal the sum of each rounded FY total.

RESEARCH AND MONITORING COSTS ($ Thousands)

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
A	**Monitor status and trend of Southern Resident killer whales**								
A.1	Continue the annual population census	2	CWR		95.4	97.4	101.5	104.7	107
A.2	Maintain a current photo-identification catalog for Southern Residents and staff able to photographically identify whales	2	CWR	Costs included under A.1					
A.3	Standardize the results of annual population surveys	3	CWR, DFO, NMFS	1 year task FY to be determined					
B	**Conduct research to facilitate and enhance conservation efforts for Southern Resident killer whales**								
B.1.1	Determine distribution and movements in outer coastal waters	1	NWFSC, DFO, WFDW, researchers		2.2	104.7	26.1	20.6	36.3

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
B.1.2	Improve knowledge of distribution and movements in the Georgia Basin and Puget Sound	1	NWFSC, SWFSC, UW, TWM		32.2	28.6	74.4	79	59.7
B.1.3	Determine the effects of prey abundance and availability, and other factors on whale distribution and movements	1	NWFSC, UW, TWM, researchers	Costs included under B.2.1					
B.2	Investigate the diet of the Southern Residents		NWFSC, DFO, WFDW, researchers						
B.2.1	Determine the diet of the Southern Residents	1			24	95.3	62.3		51
B.2.2	Determine the importance of specific prey populations to the diet	1		Costs included under B.2.1					
B.2.3	Determine the extent of feeding on hatchery fish	3		Costs included under B.2.1					
B.3	Analyze the population dynamics of the Southern Residents		NWFSC, DFO, WFDW, researchers	Total costs for B.3.1-B.3.5					

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
B.3.1	Determine causes of mortality	1							
B.3.2	Evaluate survival patterns	2							
B.3.3	Evaluate reproductive patterns	2							
B.3.4	Evaluate population structure	2							
B.3.5	Evaluate changes in social structure	2							
B.4	Investigate the health and physiology of the Southern Residents		NWFSC, DFO, WFDW, CWR, researchers	Photogram metry support (2016)	18.7	22.2	68.7	203.2	120.5
B.4.1	Assess the health of population members	2		Future costs TBD	47.5	46.7	26.7		
B.4.2	Assess individual growth rates	2		TBD					
B.4.3	Determine metabolic rates and energy requirements	1	NWFSC	Some costs included under B.4.1					
B.5	Investigate the behavior of the Southern Residents	3	NWFSC, DFO, WFDW, researchers	Some costs included under B.6.2.1					

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
B.6	Assess threats to the Southern Residents		NWFSC, DFO, WFDW, researchers						
B.6.1	Assess the effects of changes in prey populations	1							
B.6.1.1	Determine historical changes in prey distribution and abundance, and their effects on Southern Resident population dynamics	1	NWFSC, UW						
B.6.1.2	Assess changes in prey quality and their effects on Southern Resident population dynamics	1	NWFSC, UW						
B.6.1.3	Determine whether the Southern Residents are limited by critical periods of scarce food resources	1		Costs included under B.6.1.1 and B.6.1.2					

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
B.6.1.4	Assess threats to prey populations of the Southern Residents	2		Costs included under B.6.1.1 and B.6.1.2					
B.6.2	Assess the effects of human-generated marine noise and vessel traffic				36	25.6	126.4	34.8	32
B.6.2.1	Determine vessel characteristics that affect the Southern Residents	1	NWFSC, DFO, UW, researchers						
B.6.2.2	Determine the extent that vessels disturb or harm the Southern Residents	1	NWFSC, DFO, UW, researchers	Some costs included under B.6.2.1					
B.6.2.3	Determine the extent that other acoustic sources disturb or harm the Southern Residents	2	NWFSC, DFO, UW, researchers	Costs included under B.6.2.4					

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
B.6.2.4	Determine the acoustic environment of the Southern Residents	2	NWFSC, DFO, UW, researchers	Some costs included under B.6.2.1					
B.6.2.5	Determine the hearing capabilities and vocalization behavior of the Southern Residents near sound sources	2		Some costs included under B.6.2.4 and B.6.2.1					
B.6.2.6	Assess the effects of human-generated marine sound on Southern Resident prey	3		TBD					
B.6.3	Assess the effects of contaminants								
B.6.3.1	Determine contaminant levels in the Southern Residents and other killer whale communities in the northeastern Pacific	1	NWFSC, DFO, WDFW						
B.6.3.2	Determine contaminant levels in Southern Resident prey	1	NWFSC, DFO, WDFW	Costs for FY07-FY11 included under B.6.3.1					

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
B.6.3.3	Determine the sources of contaminants entering Southern Resident prey	1		Costs included under B.6.3.1					
B.6.3.4	Determine the effects of elevated contaminant levels on survival, physiology, and reproduction in the Southern Residents	1							
B.6.4	Determine risks from other human-related activities	2		As identified					
B.6.5	Evaluate the potential for disease	3		No costs identified at this time					
B.7	Identify important habitats for the Southern Residents	1	NWFSC, DFO, WFDW, researchers	Costs included under B.1.1-B.1.3					
B.8	Determine the effects of variable oceanographic conditions on the Southern Residents and their prey	1	NWFSC, DFO, WFDW, researchers	Costs included under B.1.1-B.1.3					

Task No.	Task Description	Priority	Responsible Parties	Comments	FY17	FY18	FY19	FY20	FY21
B.9	Determine genetic relationships		NWFSC, DFO, WFDW, researchers					5	
B.9.1	Determine paternity patterns in the Southern Residents	2		Costs included under B.9					
B.9.2	Determine the risk of inbreeding	1		Costs included under B.9					
B.9.3	Determine historical population size	2		Costs included under B.9					
B.9.4	Determine genetic relationships among populations	2		Costs included under B.9					
B.9.5	Expand the number of genetic samples available for study	2		Costs included under B.9					
B.10	Improve research techniques and technology	3	NWFSC, DFO, WFDW, researchers						
B.11	Research support and coordination	2	NWFSC		50	25.3			
				TOTAL BY FY	306	445.1	485.2	446.6	406.5
				TOTAL[4]	**$2,092.9**				

[4]Throughout the table, costs for specific actions and years are rounded down to the nearest hundred, which were summed for annual FY totals. The final total dollar amount for all Research & Monitoring costs reflects the actual amount spent in FY17-21 and therefore does not equal the sum of each rounded FY total.

APPENDIX B

Distribution and Habitat

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