

**Southern Resident Killer Whales
(*Orcinus orca*)**

**5-Year Review:
Summary and Evaluation**



Photo: Northwest Fisheries Science Center

**National Marine Fisheries Service
West Coast Region
Seattle, WA**

December 2016

Table of Contents

EXECUTIVE SUMMARY	1
1.0 GENERAL INFORMATION	3
1.1 Reviewers	3
1.2 Methodology used to complete the review:	3
1.3 Background:	3
2.0 RECOVERY IMPLEMENTATION	5
2.1 Cost	6
2.2 Biological Opinions	7
2.3 Addressing Key Threats.....	7
2.4 Outreach Partners.....	11
2.5 Strandings	12
2.6 Recovery Coordination	12
3.0 REVIEW ANALYSIS	13
3.1 Application of the 1996 Distinct Population Segment (DPS) policy	13
3.2 Recovery Criteria	14
3.3 Delisting Criteria.....	15
3.4 Downlisting Criteria.....	31
4.0 RESULTS	36
4.1 Updated Information and Current Species Status	36
4.2 Synthesis.....	43
5.0 RECOMMENDATIONS FOR FUTURE ACTIONS	44
6.0 ADDITIONAL REFERENCES.....	47
APPENDIX A.....	51

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 2016 after the summer census, there were only 83 individuals left in the population (CWR 2016). Their small population size and social structure also puts them at risk for a catastrophic event, such as an oil spill, that could impact the entire population. Updates regarding research and management actions for the primary threats (prey, pollution and vessels) are included below and in discussions of whether the recovery criteria related to each of the threats have been met. This review fulfills our requirement under section 4(c)(2) of the ESA to conduct, at least once every five years, a review of listed species to ensure that the listing of these species remains accurate.

Although the population of these whales, also known as orcas, has been studied for more than 40 years, we are not certain which threat is the most important to address in order to ensure recovery. 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, and identify new actions as needed.

To inform recovery, there is an active research program 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 (NWFS) developed a research plan (NMFS 2006) that informed the monitoring and research actions in the Recovery Plan. The NWFS conducts research on the whales, partners with a variety of 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.

A variety of partners have been engaged in implementing research and conservation efforts for Southern Resident killer whales for over a decade. In 2014, NMFS compiled a 10-year review of the research and conservation efforts to support recovery of the Southern Resident killer whales. The report summarizes major research findings, management activities, and remaining knowledge gaps, and discusses the threats currently faced by Southern Residents as well as actions to be taken to address them. This 5-year review identifies a number of the actions presented in the 10-year review as well as new steps that have been implemented since that review was completed. The 10-year report can be found at www.westcoastfisheries.noaa.gov.

In 2016, NMFS launched a Species in the Spotlight program, identifying eight species that are among the most at risk of extinction and initiating an agency-wide effort to spotlight and save

these highly at-risk species. Southern Residents are one of the Species in the Spotlight and we have developed an action plan to highlight a subset of actions from the recovery plan for action over the next 5 years. The Species in the Spotlight focus has helped us support existing partnerships and foster new collaborations to further recovery. High priority actions for 2016-2020 are outlined in the 2016 Species in the Spotlight 5-Year Action Plan discussed in Section 1.3.5 of this review.

Despite the implementation efforts over the long term and in the last 5 years, the population has not grown. This review provides an update on the status of the Southern Residents and our progress toward meeting the recovery criteria identified in the recovery plan. While some of the biological 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 the same: Endangered.

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–Mike Ford, Director of the Conservation Biology Program, (206) 860-5612

1.2 Methodology used to complete the review:

The West Coast Regional Office led the 5-year review and requested review by the Northwest Fisheries Science Center and Office of Protected Resources. Reports, publications, and information 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 the first 5-year review was completed in 2011 are the primary sources of information and data in this review.

1.3 Background:

1.3.1 Federal Register Notice citation announcing initiation of this review:
81 Fed. Reg. 4264, January 26, 2016- 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 endangered Southern Residents. 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 April 25, 2016, with 54 comments submitted. Among the commenters were residents of the Puget Sound region, science educators, and five representatives of environmental organizations, namely the NRDC, Oceana, The Whale Museum, The Center for Biological Diversity, and The Orca Salmon Alliance. Fifty-three of the comments expressed support for the continuation of the species' Endangered listing. Several substantive comments were submitted by environmental organizations. They included not only evidence previously considered in the original listing of Southern Residents as well as the previous 5-year review, but also new information regarding the health and viability of the species under current natural and anthropogenic pressures. Many commenters urged the agency to support the removal of the lower Snake River dams to assist in endangered Chinook salmon recovery. A number of commenters also supported the critical habitat designation amended to include coastal areas of the species' range (see 1.3.3 Associated rulemaking below).

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, 12-Month Finding on a Petition to Revise the Critical Habitat Designation for the Southern Resident Killer Whale Distinct Population Segment

1.3.4 Review History:

This is the second, formal 5-year Review for Southern Resident killer whales. The first 5-year review was completed in 2011 (NMFS 2011).

1.3.5 Species' Recovery Priority Number at start of 5-year review:

Southern Resident killer whales have a recovery Priority Number of One, based on criteria in the Recovery Priority Guidelines (55 Fed. Reg. 24296, June 15, 1990) that describes a high magnitude of threats, high recovery potential, and the potential for economic conflicts while implementing recovery actions. The Priority Number of One for Southern Resident killer whales is based on a high magnitude of threat 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 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 Southern Resident DPS could involve restrictions on commercial fishing, contaminant discharge, and vessel activities. In 2016, NMFS launched the Species in the Spotlight program to highlight conservation actions to aid in the recovery of eight Priority One species. As a part of this program, 5-year action plans have been built off of 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. Southern Resident killer whales were included in this program, and the 5-year action plan can be found at http://www.nmfs.noaa.gov/stories/2015/06/spotlight_srkw.html.

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

Even before there was a recovery plan in place for the endangered Southern Resident killer whales, 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 reducing vessel effects. 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 full list of potential threats, their associated listing factors, and the potential severity, likelihood, and feasibility of mitigation of the threat.

Table 2.1. Factors considered in listing and potentially affecting 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 restore salmon populations on the West Coast that will increase the availability of salmon for killer whales and restore the degraded nearshore habitats they share. A collaborative and comprehensive effort in Washington State- the Puget Sound Partnership- is also working to restore the area's ecological health. NMFS put vessel regulations in place in 2011 to reduce the impacts of vessels. A 10-year report released in 2014 summarizes much of the research and recovery actions that have taken place since the species was listed. These efforts have resulted from strong internal partnerships between the West Coast Region and the science centers and collaborations between NMFS and a variety of outside organizations, including Fisheries and Ocean Canada, the Center for Whale Research, the Whale Museum, and the Washington Department of Fish and Wildlife, among others. A broad summary of agency actions, collaborative efforts, and new knowledge gained over the last five years is provided in this section. Actions and progress are discussed in more detail with regard to specific threats criteria in Section 3.

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 and costs through FY2010 were provided in the 2011 5-year review. An updated implementation plan is included as Appendix A. We have updated the cost information for management, monitoring, and research actions implemented in FY2011-FY2016 for this review. Some cost information for specific high priority actions for 2016-2020 are listed in the Species in the Spotlight Action Plan. NMFS' funding represents the majority of the costs included in the implementation plan for FY2003-FY2016 and salary costs for NMFS staff working on killer whales are not included. We have included a small amount of cost information for other groups and organizations where available. The Recovery Action Mapping Tool (RAMT) has also

been created to help managers visualize recovery actions and aid in recovery coordination. RAMT is an application used to track recovery implementation for endangered and threatened species in the West Coast Region. Included in RAMT are all of the actions and projects associated with Southern Resident killer whale recovery, including NMFS funding for individual projects from FY2003- FY2016. RAMT can be accessed at <https://www.webapps.nwfsc.noaa.gov/wcr/#>.

In 2015, the National Fish and Wildlife Foundation (NFWF) created a new grant program to support Southern Resident recovery efforts. In its first year, the Killer Whale Research and Conservation Program granted \$590,000 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 grantee contributions to generate a total of greater than \$1.4 million in conservation research. More information about this program can be found at <http://www.nfwf.org/killerwhales/Pages/home.aspx>.

We are also actively seeking additional information on the efforts and expenditures of other organizations to implement actions in the Recovery Plan and have created an online form where partners can provide this type of information (http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/killer_whale/planning_implementation.html).

2.2 Biological Opinions

As mandated by section 7 of the Endangered Species Act, NMFS reviews federal actions to ensure that they do not jeopardize the continued existence of threatened or endangered species or adversely modify or destroy their critical habitat. Since Southern Residents were listed in 2005, NMFS has evaluated federal activities that directly affect the whales. NMFS also conducts consultations on the whales' primary prey—namely salmon—when those species are also listed as threatened or endangered. Notable actions that have been evaluated include the operation and continued presence of the Federal Columbia River Power System, which impacts spawning habitat for Chinook salmon, as well as urban development projects in the Puget Sound region and Navy sonar activities, among others.

2.3 Addressing Key Threats

Prey

The West Coast community has been engaged in salmon recovery for many years and recently local groups, in coordination with NMFS, have completed recovery plans for listed salmon populations. For specific information on salmon recovery, please visit: www.salmonrecovery.gov and http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead.html. The Pacific Coastal Salmon Recovery Fund (PCSRF) was established by Congress in FY2000 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. The thousands of PCSRF projects that have been implemented throughout the region have made important contributions to improve the status of ESA-listed species, prevent extinctions, and protect currently healthy populations. These accomplishments are summarized in independent reviews and annual Reports to Congress which can be found on our web page at: http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/pacific_coastal_salmon_recovery_fund.html. To monitor progress on salmon recovery, NMFS completed 5-year reviews for 27 listed Evolutionarily Significant Units and DPSs of Pacific salmon and steelhead (81 Fed. Reg. 33468, May 26, 2016). For more information on the 5-year reviews for salmon and steelhead, please visit: http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/2016_status_review.html.

In 2011 and 2012, NMFS and Department of Fisheries and Oceans Canada (DFO) appointed an independent science panel to review the effects of salmon harvest on Southern Resident killer whales. The panel held three workshops in that time to determine to what extent salmon fisheries are affecting the whales and what the consequences of those effects are to their survival and recovery. The science panel reviewed all available information, including new research called for by the outcomes of the first two workshops, and provided a final report in November 2012. The panel concluded that at a broad scale, salmon abundance will likely influence the recovery of the whales, but that there was a great deal of uncertainty about whether current fisheries remove enough salmon to have a meaningful influence on the whales' status.

The report also provided valuable recommendations on future analysis and research that could be done to fill data gaps and reduce uncertainty. The report will continue to be used to inform the management of salmon fisheries and assess impacts of actions that may alter the abundance of salmon available to the whales as part of the recovery programs for Southern Residents in the U.S. and Canada. Background information on the science panel process, workshop materials, and the final report are available at: <http://www.westcoast.fisheries.noaa.gov/>.

Contaminants

To address the threat of pollution and contamination, NMFS has worked with The Puget Sound Partnership (PSP), a Washington State agency working to restore and protect Puget Sound. The PSP in particular is leading the cleanup of Puget Sound. NMFS participated in the development of the PSP's strategy for cleaning up, restoring, and protecting Puget Sound by 2020. In 2016 the PSP released the updated 2016 Action Agenda with a list of Near Term Actions that integrate scientific assessment with community priorities, and establish a unified set of actions that are needed to protect and restore Puget Sound (PSP 2016). The Southern Resident killer whales are listed as indicators of Puget Sound's health in the Action Agenda. Killer whale recovery falls under the six recovery goals for all of Puget Sound. One of the actions identified in the Action Agenda to be completed by 2020 is to "achieve an end-of-year census of 95 individual Southern Resident killer whales, which would represent a 1 percent annual

average growth rate from 2010 to 2020.” 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/>.

The most recent pollution and contamination management efforts have been focused on an emerging contaminant— flame-retardants— known as PBDEs. Southern Resident killer whales have been found to have the highest levels of these chemicals than any other marine organism (Alonso *et al.* 2014). One of the primary vectors of contamination of PBDEs in Puget Sound is through the discharge of treated wastewater. NMFS worked with the U.S. Environmental Protection Agency to establish working groups of researchers and state and local managers to evaluate data gaps and make recommendations for the mitigation of PBDE contamination, including: 1) the removal of PBDEs from wastewater in treatment plants, 2) modeling PBDE contamination in Puget Sound, 3) determining toxicological thresholds for PBDEs in killer whales, and 4) determining the effects of mixing persistent pollutants. These working groups published a report in 2013 summarizing their conclusions, which can be found at: https://www.eopugetsound.org/sites/default/files/features/resources/PBDEs_Puget_Sound_Report.pdf.

Health

Understanding how environmental and human-caused factors influence the health of Southern Resident killer whales is crucial to not only identifying the threats faced by the species but also the actions that can be taken to aid in their recovery. In April 2015 and again in March 2016, NMFS worked with partners to host two Southern Resident Killer Whale Health Workshops to discuss potential strategies to better understand and address the decreased reproduction and increased mortality trends observed in the population. Representatives from NMFS, environmental NGOs, academic institutions, and the aquarium industry participated. Workshop attendees identified study needs, data gaps, and strategic approaches to creating a better understanding of Southern Resident health. As a result, the attendees came up with a list of actions to be initiated within 18 months, 3 years, 5 years, and greater than 5 years. High priority actions support three main goals: building an effective toolbox for research and assessment, tracking animals of interest and continuing studies related to prey and body condition, and identifying risks to reproduction and survival. Many of the actions prescribed have already been initiated, and significant collaborations with partner agencies and organizations are underway. Most notably, the DFO, the Vancouver Aquarium, the Northwest and Southwest Fisheries Science Centers, the Center for Whale Research, and University of California (UC) Davis have emerged as important partners in fulfilling the goals laid out in the priority actions. The list of priority actions developed at the 2015 workshop can be found at: <http://www.westcoast.fisheries.noaa.gov/>.

As a part of their Killer Whale Research and Conservation Program, the National Fish and Wildlife Foundation awarded \$590,000 (over \$1.4 million including matching funds) in grants to research partners in 2015. Over half of that funding awarded was consistent

with projects identified as priority actions from the 2015 Health Workshop. In particular, UC Davis was awarded funds for the development of a standardized health assessment protocol and health index as well as the creation of a comprehensive database for killer whale health records. These tools will be used to identify spatial and temporal trends in whale health, assess group and individual fitness, guide research activities, and aid in the creation of guidelines for intervention. NMFS will be working closely with the UC Davis to accomplish these goals. Additional information on the program is available at: <http://www.nfwf.org/killerwhales/Pages/home.aspx>.

Vessel Effects

NMFS has coordinated with the U.S. Coast Guard, Washington Department of Fish and Wildlife (WDFW), and DFO to evaluate the need for regulations or areas with vessel restrictions as described in the Recovery Plan. In April of 2011, NMFS published final vessel regulations in the Federal Register. They then came into effect as of May 16, 2011 (76 Fed. Reg. 20870, April 14, 2011). The final rule includes two elements: 1) a prohibition on approaching killer whales within 200 yards, and 2) a prohibition on parking in the path of the whales. WDFW also enacted state regulations with similar requirements. Additional information on the regulations is available at: www.bewhalewise.org. The new regulations were developed using the best available science and consideration of public input in order to strike a balance between providing adequate protection for the whales and allowing for an educational and economically viable whale watching industry. These regulations also call for additional education, enforcement, and monitoring activities. In 2013 and 2016, WDFW received NMFS endangered species grants to support enforcement efforts. The regulations are currently being evaluated for their effectiveness in advancing the recovery of the Southern Residents and results of the review are expected in 2017. In November 2016, NMFS received a petition from several NGOs requesting we establish a whale protection zone to support recovery of the Southern Residents. That petition is currently under review.

Many studies provided evidence for the vessel regulations and new studies continue to improve our understanding. Previously, researchers 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). Results from more recent behavioral studies can help vessel operators understand potential risks and contribute to mitigation of vessel impacts (Noren and Hauser 2016). In addition to proximity to the vessels, a NWFSC study using suction cup digital acoustic tags (DTAGs) study found that 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 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. Other recent studies have identified that noise from large ships extends into frequencies used by Southern Residents 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. 2015). The NWFSC is continuing DTAG data analysis funded by NFWF to

better understand how vessel-generated noise influences the subsurface behavior of Southern Residents, especially foraging behaviors (NFWF 2015).

NMFS has joined a new partnership lead by the Port of Vancouver called the Enhancing Cetacean Habitat and Observation (ECHO) Program. The ECHO Program supports projects aimed at understanding the impacts of vessel activity on Northwest whales, including Southern Residents. These impacts include acoustic and physical disturbance, environmental contamination, and prey availability. The goal of the program is to develop management regimes to better address the threats that vessels pose to at-risk whale species. More information about the ECHO Program can be found at <http://www.portvancouver.com/environment/water-land-wildlife/marine-mammals/>.

Oil Spill Threat

NMFS worked closely with partners to address the threat of an oil spill in the killer whales' habitat by developing a killer whale-specific oil spill response plan. NMFS and UC Davis hosted a workshop with researchers, oil spill responders, and oil industry representatives and developed a draft oil spill response plan for killer whales. Working with WDFW, the Region 10 Regional Response Team and the Northwest Area Committee, we completed the plan, and it was adopted in the Northwest Wildlife Response Plan as part of the Northwest Area Contingency Plan, which can be found at <http://rrt10nwac.com/NWACP/Default.aspx>. WDFW and other partners have participated in drills to practice implementation of the response plans, including an on-the-water drill in March 2013 to practice the use of deterrents methods. In addition, NMFS has continued to work with partners to gather more information on the available deterrents methods, such as recording the sounds from helicopters and banging pipes, to evaluate the most effective distances and deployments.

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 recovery of the Southern Residents and how individuals and organizations can contribute to conservation. A few examples of our partnerships and education and outreach programs include:

- The Seattle Aquarium created 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).
- 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).

- The Port Townsend Marine Science Center inspires conservation of the Salish Sea with their Orca Project and as part of the Salish Sea Hydrophone Network (<http://www.ptmsc.org/>).
- NMFS developed a high school level curricula on killer whale recovery aligned with state learning requirements (www.nwr.noaa.gov/upload/HS-orca.pdf).

2.5 Strandings

Stranded killer whales provide valuable opportunities for us to learn about the status and threats to the population. 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 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, and partners from the U.S. and Canada have developed a detailed Killer Whale Necropsy and Disease Testing Protocol, which has been recently updated (Raverty et al. 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 is also supported through the John H. Prescott Marine Mammal Rescue Assistance Grant Program. Gaydos and Raverty (2010) have compiled available information on stranded killer whales and causes of death, when known, since the Southern Residents were listed and analysis of killer whale strandings along the West Coast are ongoing.

Data collected from three Southern Resident killer whale strandings in the last five years have contributed to our knowledge of the health of the population and the impact of the threats to which they are exposed. Transboundary partnerships have supported thorough necropsies of L112 in 2012, J32 in 2014, and L95 in 2016, which included testing for contaminant load, disease and pathogens, organ condition, and diet composition. Reports for those necropsies are available at: http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/killer_whale/rpi_strandings.html. A final necropsy report for J34, who was found dead near Sechelt, British Columbia on December 20, 2016 is still pending, but the initial findings can be found at: <http://www.pac.dfo-mpo.gc.ca/fm-gp/species-especes/mammals-mammiferes/srkw-eprs-j34-eng.html>. Necropsy results from several stranded calves over the last five years and reviews of other killer whale strandings along the coast are still pending.

2.6 Recovery Coordination

NMFS continues to coordinate with Federal, state, and international agencies regarding killer whale recovery programs. The U.S. Coast Guard, WDFW, and DFO were cooperating agencies on the Environmental Assessment for the vessel regulations described above. In addition, NMFS and DFO participate in each other's meetings regarding killer whale recovery to share information, provide updates on recovery actions, and ensure consistency on both sides of the border whenever possible. DFO released an Action Plan in 2016 for Southern and Northern Resident killer whales under

their Species at Risk Act. In alignment with the NMFS Recovery Plan, the DFO Action Plan focuses on the primary threats to survival: prey availability, human disturbance such as vessel impacts, and contaminants. It also establishes protections for critical habitat (Fisheries and Oceans Canada 2016). The Action Plan can be found at the DFO website (http://www.registrelep-sararegistry.gc.ca/document/default_e.cfm?documentID=2944).

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?

- ☒ **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?

- ☒ **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.
☒ **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.

☒ **No**, go to section 3.2., Recovery Criteria.

3.2 Recovery Criteria

3.2.1 Does the species have a final, approved recovery plan¹ containing objective, measurable criteria?

☒ **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?

☒ **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 January 2016, NMFS released the announcement of this impending review in the Federal Register and solicited comments, including input on the adequacy of the recovery criteria (81 Fed. Reg. 4264, January 26, 2016). The comment period closed on April 25, 2016 and 54 comments were received, none of which pertained to the recovery criteria. However, NMFS will continue to evaluate the criteria moving forward and seek input prior to making any revisions.

One set of suggestions regarding recovery criteria was provided in 2012 in the report released by the Independent Science Panel (Hilborn et al. 2012), which comments on the utility of different types of recovery criteria. Although there are benefits and drawbacks associated with any metric used for assessing recovery of an endangered species, Hilborn et al. (2012) outline five main requirements of any recovery criteria. These include:

- 1) The establishment or choice of measurable population characteristics such as abundance and growth rate by which to determine population status

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.

- 2) Thresholds for these characteristics that define the status of the population
- 3) The probability that these thresholds will be met
- 4) The amount of time over which the chosen characteristics should be measured
- 5) A clearly defined method for measuring those characteristics

The recovery criteria included in the Recovery Plan currently meet four of the five requirements outlined by the Panel. The fifth requirement—the selection of a metric for measuring population growth rate— requires further review and consultation before any updates to the recovery criteria are made.

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.)*

☒ **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.

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

Biological 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. Over the last 28 years the population size has fluctuated, and there has not been an average increase per year for the population. In 1982 there were 85 whales and in 2016 there were 83 whales counted in the summer census, with 78 surviving at the time of this report. Following the census four additional missing whales have been confirmed dead by the Center for Whale Research and one whale was found stranded in December 2016.

There is representation in all three pods, J (24 whales), K (19 whales), and L (35 whales). There are currently 4 reproductively mature males in J, 8 in K, and 10 in L pod between the ages of 10 and 42 years old. Of the 78 individuals in the population, 22 of them are reproductive age males and 27 are reproductive age females. However, based on an updated pedigree from new genetic data, most of the offspring in recent years were sired by two fathers, meaning that less than 30 individuals make up the effective reproducing portion of the population. Because a small number of males were identified as the fathers of many offspring, a smaller number may be sufficient to support population growth than was previously thought (Ford et al. 2011, NWFSC unpublished data). In addition many offspring were the result of matings within the same pod raising questions and concerns about inbreeding effects. Research into the relationship between genetic diversity, effective breeding population size, and health is currently underway to determine how this metric can inform us about extinction risk and inform recovery (NWFSC unpublished data).

The age and sex class distribution is similar for both Northern Resident and Southern Resident populations (Tables 3.1 and 3.2). If we assume the Northern Resident 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 Southern Resident females is 6.1 years, which will allow for population growth, but likely at a slower rate than observed for Northern Residents, 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. Because the Southern Resident population is so small, age and sex composition are more 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 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 population demographics in 1979 versus most recent levels.

	SRKW 1979 (%)	SRKW 2016 (%)	NRKW 1979 (%)	NRKW 2010 (%)
Juveniles (< 10)	37	31	33	38
Adult males (10+)	18	29	31	22
Adult females (10-42)	27	33	32	34
Post-reproductive females (42+)	19	7	4	7

The NWFSC continues to evaluate changes in fecundity and mortality 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 from that work, including data from the last 5 years, 2011 through 2016, now suggests a downward trend in population growth projected over the next 50 years, in part due to the changing age and sex structure of the population, but also related to the relatively low fecundity rate observed over the period from 2011 to 2016 (Figure 3.1). The population trend projection is most pessimistic if future fecundity rates are assumed to be similar to those in 2016, and less steep but still declining if an average fecundity rate over the last five years is used for the projections (Figure 3.1). The projection using 2011 through 2016 fecundity data shows some stability and even a slight increase over the next decade. As the model projects out over a longer time frame (50 years) there is increased uncertainty around the estimates, however, if all of the parameters in the model remain the same the overall trend shows a decline in later years. Using more variable survival and fecundity rates may be more representative than relying on the single poor year of 2016, but this single year scenario provides information on what could happen if poor reproduction continues. Deviations from the assumptions underlying these projections may lead to more pessimistic or optimistic trajectories. For example, these growth trends assume the ratio of female to male births is 50:50; however, over the last five years new births have been skewed slightly toward male, and over the entire time series the proportion of births that are female is closer to 43 to 44 percent. A second factor is the potential effects of inbreeding (generally a risk for any small population). The NWFSC is continuing 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. 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 a number of actions underway to target recovery of critical prey, reduce vessel impacts and better understand how several health related factors influence reproduction. As actions are implemented and we can improve our ability to evaluate and mitigate risks, we hope to see improvements in the vital rates of the population.

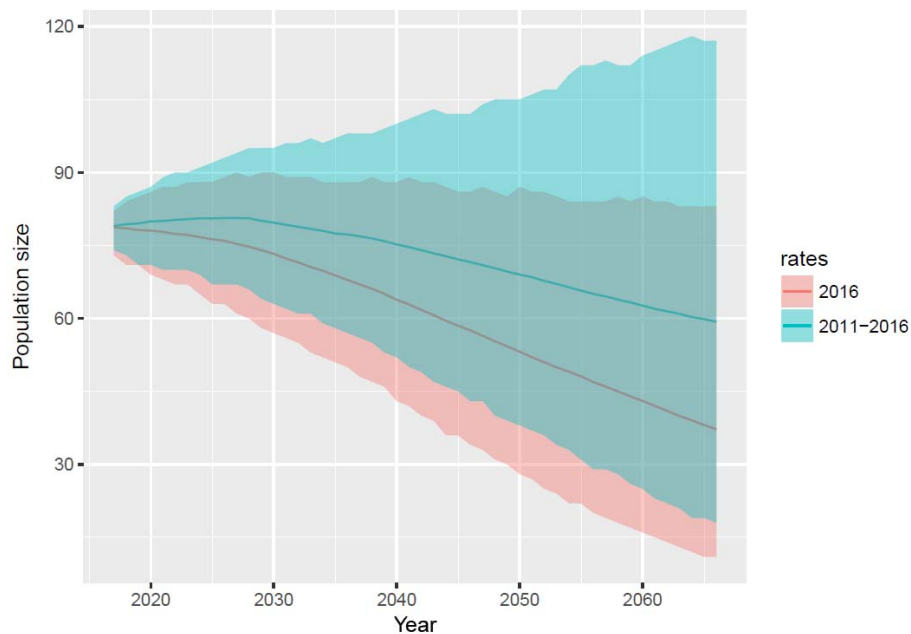


Figure 3.1 Southern Resident killer whale population size projections from 2016 to 2066 using 2 scenarios: (1) projections using demographic rates held at 2016 levels, and (2) projections using demographic rates from 2011 to 2016. The pink line represents the projection assuming future rates are similar to those in 2016, whereas the blue represents the scenario with future rates being similar to 2011 to 2016.

These analyses provide insight into the current status of the population and how different factors may affect future population growth, although uncertainty increases the farther out you make predictions. Because the population is so small, slight changes in births and the sex of calves can have a big influence on modeled future population growth. Vital rates, and in particular fecundity, has varied over time and it is essential to continue closely tracking the population through the annual census and other studies to update the models and projections and understand the status, extinction risk, effectiveness of recovery actions, and recovery potential for the population.

3.3.1 Threats Criteria

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.

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, the threats criteria for Factor A have not been met. While there has been significant progress in assessing the habitat needs of the whales, more research is needed to help us 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.

A1. There is ongoing research and analysis underway to assess the health of the whales and evaluate if prey is a limiting factor for recovery of Southern Resident killer whales. Both United States and Canadian researchers have conducted statistical studies revealing relationships between overall coastwide Chinook salmon abundance indices and Southern Resident killer whale survival, social cohesion, growth rate, and fecundity (Fearnbach et al. 2011; Ford et al. 2010; Ward et al. 2009; Ward et al. 2013). New studies utilizing aerial photogrammetry to study body condition methods are useful in the study of individual and

population-wide health. Aerial photogrammetry allows researchers to take measurements of the whales' length and width to assess individual body condition. Fearnbach et al. (2011) found indications of decreased body size in young adults as a result of nutritional stress during early growth. These data are important for the study of population-wide response to environmental stress (Fearnbach et al. 2011; Durban et al. 2009). Additional information on the health status and body condition of the whales and distribution of their prey would clarify where and when the whales may be food limited, and what other factors may contribute to the observations by Fearnbach et al. (2011) and Durban et al. (2009).

Although nutritional stress is a possible cause of poor body condition and reduced body size, disease, organ malfunction, vessel disturbance, and prey contamination could also be behind the conditions observed for individual whales in aerial photogrammetry studies (Hilborn et al. 2012). More research into these confounding factors and the effects that they have on the whales is needed to fully understand how external influences affect Southern Resident killer whale health. One of the projects funded by the NFWF Killer Whale Research and Conservation Program in 2015 aims to fill this data gap. The Vancouver Aquarium Marine Science Centre received the funding to conduct an ongoing, multi-year study of the impacts of prey availability and contaminant load on killer whale body condition. This study uses aerial photogrammetry to rate body condition as well as biopsies from the corresponding whales to help quantify the effects of contamination and poor nutrition (NFWF 2015).

In another new study, University of Washington researchers are using fecal samples to evaluate the health of Southern Residents. Specifically, these researchers are using hormone measures of stress (glucocorticoids, or GCs) and nutrition (triiodothyronine, or T3) in feces to determine the physiological impacts of nutritional and psychological stress, presumably caused by vessel disturbance and lack of prey (Ayers et al. 2012). This study has shown reduced T3 values in Southern Residents during late spring and summer, which indicates nutritional stress during the period spent in the Salish Sea. Elevated T3 values in the early spring when the whales first arrive in the area, however, indicate that the whales are foraging on prey with high nutritional value before they get there, suggesting the importance of coastal early spring run salmon (Ayers et al. 2012). However, a lack of data from winter months and understanding of variability in the data limits the utility of this information and makes it difficult to assess the overall nutritional status of the whales based on these values alone (Hilborn et al. 2012).

Reduced feeding behavior has been reported when vessels are present and it is estimated that the presence of vessels could result in an 18 percent decrease in energy intake, a consequence that could have a significant negative effect on an already prey-limited species. (Lusseau et al. 2009; Williams et al. 2006); however, we do not have sufficient information to quantify this reduction in feeding for individual whales or evaluate the cumulative effects of all vessel traffic that may be changing the whales' behavior. Actions to address the impact of vessels are discussed in more detail below under A4 and under Factor B, criteria B1.

Since the last 5-year review, there have been two deceased killer whales that exhibited some signs of nutritional stress at the time of necropsy. The first, J32, was deemed to be in "fair body condition", with some generalized, moderate emaciation and prominent vertebrae (Ford

2013). The second, L95, was found to be in “moderate to fair body condition” at the time of necropsy. Photos taken a month before death showed rib outlines, possibly indicating nutritional stress (Raverty 2016). It is unclear to what extent nutritional stress may have contributed to the deaths of these two individuals, however lack of prey cannot be ruled out as a significant contributor.

- A2. A number of studies and evaluations of management actions have contributed to our knowledge of foraging ecology and potential effects from fisheries on the whales. One recent study conducted by the NWFSC and partner organizations used fecal DNA analysis to confirm the results of previous studies conducted using other prey identification methods (Ford et al. 2016). Their findings confirmed previous studies using the remains of prey left behind during foraging events to determine the diet of the whales (Hanson et al. 2010). They found that salmonids make up greater than 98 percent of Southern Resident killer whale diet with Chinook salmon comprising 79.5 percent of the overall diet. However, while previous studies did not detect a significant amount of coho salmon in the diet, Ford et al. (2016) discovered that coho were responsible for at least 15 percent of the diet, and that they were an important prey species during times of decreasing seasonal Chinook salmon abundance. This indicates that the whales shift to other prey items in the absence of Chinook salmon (Ford et al. 2016; Hilborn et al. 2012).

Several studies have also used genetic identification methods and energy content analysis to estimate the river of origin of salmon consumed by the whales and to explain their preferences for certain stocks. Most Chinook salmon prey samples (80 to 90 percent) from summer feeding events in the Salish Sea originated from the Fraser River and stock identification also showed a high likelihood that the whales consume hatchery fish, indicating that hatcheries could be making important contributions to Southern Resident recovery (Hanson et al. 2010). Fraser River Chinook salmon were found to have the highest total energy content of all of the Chinook runs from the region found in the whales’ range and diet, while Puget Sound Chinook salmon were found to have significantly lower total energy (O’Neill et al. 2014). These studies and others conducted to implement the research actions in the Recovery Plan inform fishery management programs that determine harvest limits and hatchery practices.

Salmon harvest actions are evaluated under the ESA to ensure that the harvest management regimes will not jeopardize the continued existence of ESA-listed salmon or killer whales or adversely modify their designated critical habitat. In recent years, NMFS has completed section 7 consultations on several fisheries including the Pacific Salmon Treaty (NMFS 2008b), Pacific Coast Salmon Fisheries (2008c), and the Puget Sound Salmon Fisheries (NMFS 2016). These consultations contain the most up-to-date information on foraging ecology of the whales and we considered published papers from all sources and unpublished data from the NWFSC. Our analyses also include many assumptions and we have identified gaps in our knowledge, such as a lack of information about the foraging efficiency of the whales. In each of these consultations we examined the percent reductions in the killer whales’ prey base from harvest. We also analyzed the number of Chinook salmon or kilocalories from Chinook salmon food energy remaining after the fisheries as compared to our estimates of the Chinook salmon needs of the whales.

Our analyses for the fisheries consultations characterize the short-term and long-term effects on Southern Residents from prey reduction caused by harvest. Effects anticipated on an annual level are considered short-term (i.e., harvested Chinook salmon in a given year). Our estimates of short-term prey reductions from fisheries have been small relative to remaining prey available to the whales to meet their prey needs. Long-term effects consider the potential for the action to affect viability of prey at the salmon stock or Evolutionarily Significant Unit, (ESU)-level over a longer time frame. In the long term, the harvest actions we have analyzed have met the conservation objectives of harvested stocks, were not likely to appreciably reduce the survival or recovery of listed Chinook salmon, and were therefore not likely to jeopardize their continued existence.

We considered both the short- and long-term components of the analysis to inform our conclusions for Southern Residents. The harvest consultations referenced above concluded that the harvest actions cause small prey reductions, but were not likely to jeopardize the continued existence of ESA-listed Chinook salmon or Southern Residents, or adversely modify their critical habitats.

An independent science panel convened in 2011 and 2012 to analyze the effects of salmon fisheries on both Chinook salmon abundance and Southern Resident recovery (see Table 3.3). Their final report, published in 2012, concludes that there is little evidence that a reduction in salmon catch would have long-term benefits for Southern Resident killer whales (Hilborn et al. 2012). Not enough information is known regarding other sources of salmon mortality and the dynamic ocean food web that determines the amount of Chinook salmon available to Southern Residents to identify harvest management measures that would benefit the whales. Furthermore, salmon fisheries target Chinook salmon from several different runs, not just those that are important to Southern Residents, making it difficult to understand how reducing fishing effort on Chinook salmon would impact prey availability for the whales. The panel concluded that the 2.3 percent growth rate necessary for delisting the species is unlikely to be achieved by simply reducing Chinook salmon fisheries, but that efforts to restore important Chinook salmon habitat may increase the carrying capacity of Southern Resident prey species. The report noted that these actions, unlike a reduction in salmon fishery harvest, would likely have greater long-term benefits for the whales (Hilborn et al. 2012).

Table 3.3. Summary of panel’s research recommendations (page numbers in Hilborn et al. 2012 in parentheses)

Recommendation	In Recovery Plan?	Status of Research in Progress
Collect information on the Southern Resident coastal diet and distribution (v, xii, 18, 20, 21, 23, 38)	Yes	Ongoing sample collection during coastal cruises
Collect more information on stock-specific Chinook salmon distribution during winter (35, 38)	Yes	Sample analysis conducted on coastal samples, manuscript in development
Better quantify Chinook salmon consumption by other predators, particularly seals and sea lions, including updated abundance estimates of these predators (ix, 38, B-4)	No	Pacific Salmon Commission funded food web modeling project 2015-2016 (Chasco et al. in press), additional modeling underway
Gain more realistic understanding of Southern Resident dynamics as a function of both prey abundance and abundance of other predators; better quantify abundance of Chinook salmon that would be made available to Southern Resident through fishery reductions fishery removals (competing risk of death models) (ix, 33, 35, 38, 51, 52)	No	Competing risk of death model considered in Pacific Salmon Commission project (Chasco et al. in press)
Collect information on seasonal differences in Southern Resident metabolism, condition, and prey consumption. (21, 22, 24, vi)	Yes	Seasonal photogrammetry project funded through NFWF for 2016-2017
Evaluate relationship between salmon abundance and whale condition (vi, xii, 24)	No	Continuing evaluation of relationships as part of risk assessment development
Better quantify the effects of alternative fishing scenarios on long-term abundance of Chinook salmon (36)	No	NFWF funded project studying the effects of hatchery practices on prey availability for Southern Residents for 2016-2017 (NFWF 2015), Thesis assessing the effects of fisheries and hatchery production on prey availability (Strange 2016)
Research to characterize potential catastrophic risks faced by Southern Resident (52)	Yes	Ongoing risk assessment work considers a survival threshold regarding catastrophic risk
Better estimates of the carrying capacity of Southern Resident and whether they are currently experience density dependent growth	No	NWFSC population viability analysis performed annually

A. Models used for salmon harvest management, such as the Fishery Regulation Assessment Model (FRAM) (described in NMFS 2008b), account for natural mortality, but natural mortality is not calculated based on estimates of what marine mammals are consuming. Natural mortality is essentially determined by calculating the difference between counts of smolts exiting rivers and counts of adults returning to the rivers, and considering the number of fish harvested.

B. For each of the fishery actions identified above, NMFS conducted section 7 consultations to ensure that the fisheries do not jeopardize the continued existence of ESA-listed salmon. For example, the consultation for the Puget Sound salmon fisheries described above for killer whales also includes an analysis of effects on listed salmon (NMFS 2016). For additional information on salmon fishery consultations including a description of the approach for harvest decisions for ESA-listed salmon and steelhead please visit our web page at http://www.westcoast.fisheries.noaa.gov/fisheries/salmon_steelhead/salmon_and_steelhead_fisheries.html.

A3. Since research on the effects of environmental contaminants on Southern Residents began in the early 1990s, it has been widely known that persistent organic pollutants (POPs) or “legacy contaminants” are of particular concern to the whales. PCB levels have been detected in blubber samples at concentrations that far exceed the threshold known to have detrimental health effects on harbor seals in Puget Sound. High concentrations of PCBs have been linked to changes in gene expression in killer whales, particularly in those genes related to endocrine and immune function as well as important metabolic processes (Buckman et al. 2011). However, despite their persistence in the marine environment, recent analysis indicates that PCB levels may be declining in Puget Sound harbor seals, a promising result for the whales (Ross et al. 2013). 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 2014). In the last five years, however, the focus on POPs has shifted toward one emerging contaminant in particular—PBDEs.

PBDEs have been used in many common household and industrial products as flame retardants since the 1970s. They are not chemically bound to the products that contain them, which makes them particularly prone to leaching out into the environment (Gockel and Mongillo 2013). In the United States and Canada, the three forms in which PBDEs exist as flame retardants were banned from production and importation in 2004 and 2013. However, they remain in many consumer products made before that time, so their release is ongoing and their concentrations in the marine environment may continue to increase in the coming years (Lundin et al. 2015; Gockel and Mongillo 2013; Ross et al. 2013; Mongillo et al. 2012). The largest pathway of contamination in Puget Sound is atmospheric deposition, which accounts for about 44 to 56 percent. PBDEs become detached from indoor products and then bind to dust particles and are delivered into waterways via wastewater (Gockel and Mongillo 2013). Although direct evidence of the effects of PBDEs on killer whale health is lacking, studies in proxy species such as sea lions and harbor seals suggest similar effects to PCBs, including immune and endocrine disruption, cancer, decreased reproduction, and

increased calf mortality (Mongillo et al. 2012; Gockel and Mongillo 2013; Lundin et al. 2015). In response to this emerging threat, NMFS and the U.S. EPA convened several working groups and a policy forum to make recommendations on how to monitor and address PBDE contamination in Puget Sound. The results of these meetings can be found at https://www.eopugetsound.org/sites/default/files/features/resources/PBDEs_Puget_Sound_Report.pdf.

One major obstacle to setting specific recovery goals for reducing the contaminant load in Puget Sound is a lack of data supporting an effects threshold for killer whales. Several studies have been conducted on other species of marine mammals to determine the level at which specific contaminants have detrimental health effects, but these studies are more difficult to conduct on cetaceans. Furthermore, the time lag between prey consumption, contaminant storage in blubber, and physiological response makes it difficult to say with any certainty that contaminants are responsible for those responses (Gockel and Mongillo 2013). However, some studies in the last five years have focused on improving methods for studying the effects of contaminants on killer whales. The results from these studies indicate that researchers may be getting closer to being able to establish effects thresholds that will be able to guide recovery implementation. For example, methods for analyzing scat are allowing researchers to determine contaminant loads while simultaneously testing for stress hormones. Correlating physiological evidence of stress with contaminant load may provide evidence for the health effects of PCBs and PBDEs on Southern Residents (Ayers et al. 2012; Gockel and Mongillo 2013; Lundin et al. 2015). Still, many of the contaminant studies of killer whales rely on small sample sizes and additional work is needed to track trends in individual animals over time and to link physiological effects with different levels of various contaminants. The health database described in Section 2.3 will help organize this data and allow researchers to develop models to better understand the health effects of certain thresholds of contamination in killer whales.

NMFS recently released a technical memorandum reviewing existing information about the threats that contaminants pose to Southern Residents. The authors make several recommendations to fill the data gaps that are currently hindering efforts to reduce these threats. These include developing new biomarkers for toxicity, utilizing non-invasive methods to measure contaminant load, and correlating contaminant load with health and reproduction. By closing these data gaps, management actions can be put in place to reduce exposure, monitor long-term contaminant levels, and determine the risks posed by persistent organic pollutant in Southern Residents (Mongillo et al. 2016).

- A4. NMFS has taken several management actions to reduce vessel disturbance, the most significant of which has been implementing mandatory regulations in May of 2011 (76 Fed. Reg. 20870, April 14, 2011). The final rule includes two elements: 1) a prohibition on approaching killer whales within 200 yards, and 2) a prohibition on parking in the path of the whales. These regulations apply to all killer whales, not just Southern Residents, since it can be difficult to identify the ecotype of any given whale.

NMFS has continued to work with partners to enforce the new regulations and advance education campaigns to raise boater awareness. In 2013 and again in 2016, WDFW received

3-year ESA Section 6 grants to assist enforcement efforts. They spend several days a week from May to October on the water giving out warnings and citations to vessel operators who violate the regulations, as well as passing out information regarding state and federal boating laws. The Soundwatch Boater Education Program out of the Whale Museum also spends at least 4 days on the water every week during the summer to record violations and educate boaters on the regulations (Seely 2015). NMFS has also continued to promote the voluntary Be Whale Wise guidelines through Soundwatch, WDFW, the Seattle Aquarium, the Orca Network, and other partners.

NMFS also considered including a no-go zone prohibiting vessels from entering a 6 square mile area along the west side of San Juan Island from May 1 to September 30 in proposed vessel regulations, but did not include it in the final rule after receiving a large number of public comments opposing the action. However, a no-go zone in this important foraging area is still being considered and in 2016 NMFS received a petition requesting establishment of a whale protection zone. The petition is currently under consideration.

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 Southern Residents. NMFS has also made progress in addressing overutilization of Southern Residents by developing regulations to reduce vessel disturbance.

- B.1 Actions to reduce vessel disturbance are described above under A4. NMFS' regulations are intended to reduce the number of potentially harmful incidents when vessels are not following the responsible viewing guidelines. Although the regulations have only been in place for a short time, the final rule includes detailed information on what long-term benefits NMFS expects for the regulations. A seasonal no-go zone on the west side of San Juan Island is still under consideration, although the measure was not included in the final vessel regulations in 2011. NMFS will continue to work with the Soundwatch Boater Education Program and WDFW to monitor the 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. A review of the current regulations is currently underway and NMFS has also received a petition requesting establishment of a whale protection zone.

B.2 The public display industry has not requested authorization to remove Southern Resident killer whales from the wild and NMFS has not authorized any live captures. Incidental take in fisheries is not currently a threat to Southern Resident killer whales (Caretta et al. 2010). However, potentially harmful interactions with fishing gear do sometimes occur. In 2015, a member of the J-pod— J39— was photographed with a salmon fishing flasher dangling out of his mouth. Five days later, J39 was photographed again by the Center for Whale Research without the flasher. There were no signs of any damage to the tissue around his mouth (Balcomb 2015). Continued monitoring has shown no negative consequences of this fishery interaction. However, 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.

In 2016, the death of L95 may have been connected to research activities. A necropsy revealed that a limpet-style satellite tag may have provided a vector for a fungal infection that ultimately contributed to the death of the animal. An expert panel concluded that several factors seem to have predisposed L95 to this fungal infection, including poor body condition, tag placement and malfunction, contamination of the tag from sea water, and even immunosuppression. Although mortality due to complications from satellite tagging is rare (and in this population, unprecedented), the panel made several recommendations for improving the tagging protocol and further decreasing the risk to the whales. For the time being, NMFS has suspended the tagging program for further review. The report from the expert panel can be found at http://www.westcoast.fisheries.noaa.gov/publications/protected_species/marine_mammals/killer_whales/l95_expert_panel.pdf.

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 reproduction and survival of Southern Residents.

C1. Gaydos et al. (2004) reviewed potential infectious disease threats for Southern Resident killer whales. While the social structure and small size of the population put them at risk of infectious disease, we have not identified infectious disease as a limiting factor for the Southern Resident killer whale population. We do not, however, have sufficient information to ensure that disease is not affecting the population, nor do we understand how other threats such as contaminants and prey availability may impact the susceptibility of Southern Residents to disease. It is hypothesized that certain contaminants may have negative

consequences for the immune system, however no direct observations or measurements have been made to support this theory. More research is required to determine how the threats addressed under Factor A may affect the population's ability to withstand disease. Several priorities from the health workshop address data gaps regarding disease.

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.

- D1. We do not currently have sufficient baseline or trend information to evaluate if contaminant loads and accompanying physiological impacts are limiting recovery and sustainability of Southern Residents. As described above under A3, there is some information on trends and levels of emerging contaminants in killer whales and other marine mammals; however, many of the contaminant studies of killer whales rely on small sample sizes and additional work is needed to track trends in individual animals over time and to link physiological effects with different levels of various contaminants.
- D2. To address the threat of pollution and contamination, NMFS participated in efforts of the Puget Sound Partnership to develop a strategy for cleaning up, restoring, and protecting Puget Sound by 2020. In 2016, the Partnership released an updated Action Agenda which integrates scientific assessment with community priorities, and establishes a unified set of actions that are needed to protect and restore Puget Sound (Puget Sound Partnership 2016).

NMFS also collaborated with the U.S. EPA to conduct a series of workshops to assess the presence and impact of PBDEs on the Puget Sound ecosystem and Southern Resident killer whales. The working groups formulated a set of recommendations to address the issue of PBDE contamination in Puget Sound. 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 for information on our efforts to assess contaminant trends and our need for additional information on potential harm from different levels of various contaminants.

D3. See A4 and B1 above for information on actions to reduce disturbance by vessels, including commercial and recreational whale watching.

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?

No, not all of the threats criteria for Factor E have been met. Additional information is necessary to evaluate the distribution, habitat use, and potential risks to the Southern Residents in the coastal portion of their range. NMFS, along with partners, has made significant progress on other criteria by developing an oil spill response plan and supporting the annual census.

E1. NMFS is working closely with partners to address the threat of an oil spill in the killer whales' habitat by developing a killer whale-specific oil spill response plan. In 2007, NMFS and UC Davis hosted a workshop with researchers, oil spill responders, and oil industry representatives and developed a draft oil spill response plan for killer whales. Working with WDFW, the Region 10 Regional Response Team, and the Northwest Area Committee, we completed the plan, and it was adopted as part of the Northwest Area Contingency Plan. NMFS is continuing to work with WDFW to develop specific implementation strategies for the hazing techniques identified in the plan.

- E2. NMFS is not aware of any reduction in oil spill prevention practices. In 2009, Washington Department of Ecology (Ecology) released the 2007-2008 Spill Prevention, Preparedness, and Response Program Report (Ecology 2009). The report includes information on partnerships, new initiatives, incidents, and performance. While the volume of oil released has been decreasing, the number of spills has remained steady for the last 20 years. The report identifies future actions to address chronic pollution sources. 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 <http://www.ecy.wa.gov/programs/spills/spills.html> 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 Southern Resident killer whale 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.
- E4. The Southern Resident killer whales spend more than half of their time in coastal offshore waters, primarily in winter months, and learning more about how they are using this habitat has been a top priority since the listing when only a handful of sightings existed. In 2014 NMFS received a petition requesting an expansion of critical habitat to include offshore waters of the Pacific Ocean. We 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). New information from ongoing research through passive acoustic monitoring, land-based sightings, coastal research cruises, and satellite-linked tagging conducted over the last 5 years will inform the critical habitat revision. Critical habitat identifies physical and biological features that are essential to the conservation of listed species. Revising critical habitat to include coastal portions of the whales' habitat will ensure that federal actions won't adversely modify, destroy, or otherwise reduce the conservation value of this habitat. Descriptions of critical habitat are also a powerful educational tool, illustrating important habitat features and specific areas where those features are found. Studies on coastal habitat use are also critical to our understanding of the key prey for the whales during the winter months, have provided information on reproduction, and help us understand potential threats in offshore waters.

Research projects have increased our knowledge of distribution, habitat use, and potential risks to the population in the coastal portion of the range of Southern Residents. The NWFSC, along with many 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. 2009b). The NWFSC has also conducted dedicated ocean class shipboard visual and acoustic surveys to locate and track killer whales. On eight of the past nine cruises, NWFSC scientists have located the Southern Residents along the Washington and Oregon coasts. Between 2012 and 2016 the NWFSC deployed eight satellite tags on individual Southern

Residents to track their movement during the winter months when they leave Puget Sound. Analysis of the satellite tag data is currently underway and will inform designation of coastal critical habitat for the whales. More information on the satellite tag program is available at https://www.nwfsc.noaa.gov/research/divisions/cb/ecosystem/marinemammal/satellite_tagging/.

3.4 Downlisting 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. Although there is currently representation in all 3 pods, only 78 individuals exist in the entire population, down 19 from 1996.

There is representation in all three pods, J (24 whales), K (19 whales), and L (35 whales). There are currently 5 reproductive age males in J, 8 in K, and 9 in L pod. The current population is 31 percent juveniles, 33 percent reproductive females, 29 percent reproductive males, and 7 percent post-reproductive females.

3.4.1 Threats Criteria

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 of the threats. NMFS and the Pacific Northwest community have made progress in completing a number of salmon recovery plans and developing regulations 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 additional information is needed, particularly for emerging contaminants.

- A1. Salmon ESA recovery planning is underway throughout the entire West Coast Region. While each recovery plan will meet ESA requirements and will use consistent scientific principles, each plan will be unique because of conditions in that domain, and because it will be based on local initiatives. Recovery-related products are in varying stages of development. Final recovery plans are in place for Puget Sound Chinook salmon, Lake Ozette Sockeye salmon, the Lower, Middle, and Upper Columbia salmon, Willamette River salmon, Southern Oregon Northern California Coast Coho salmon, Central California Coast Coho salmon, California Central Valley salmon, and Southern California Coast Steelhead; other plans are in development. For additional information on the status of salmon recovery plans, please visit http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/recovery_plans_supporting_documents.html.
- A2. Several research projects are underway to increase knowledge of the foraging ecology of Southern Residents. Hanson et al. (2010), O'Neill et al. (2014), and Ford et al. (2016) published summaries of information on prey consumed by Southern Resident killer whales, confirming a high percent of Chinook salmon in the diet of Southern Residents in their summer range. These studies also used genetic identification methods to estimate the river of origin of salmon consumed by the whales. Most Chinook salmon prey samples (80 to 90 percent) originated from the Fraser River, and stock identification also indicated a high likelihood that the whales consume hatchery fish (Hanson et al. 2010; O'Neill et al. 2014). In addition to information on prey consumed by the whales, we have updated information on the metabolic needs of the whales which also informs foraging ecology (Noren 2011; Williams et al. 2011; O'Neill et al. 2014). Finally, in 2011 and 2012 an Independent Science Panel convened to determine the effects of ocean salmon fisheries on Southern Residents. Their final report indicates that reducing fishing effort would not have long-term benefits for Southern Residents, and that more information regarding other sources of natural salmon mortality is needed to understand how reducing ocean salmon fishing would impact the

whales' prey availability (Hilborn et al. 2012). These studies and others conducted to implement the research actions in the Recovery Plan inform fishery management programs that determine harvest limits and hatchery practices (Table 3.3).

There are still major data gaps regarding the foraging ecology of the whales. Although still limited, we have substantially increased information on winter coastal distribution of Southern Resident killer whales through a coastal sighting network, ocean-class vessel survey cruises, and autonomous passive acoustic recorders (Hanson et al. 2008a, 2008b, 2009a, 2009b). However, we have very little information on the whales' diet in their winter range along the Pacific Coast. Another major data gap is a lack of information on foraging efficiency of the whales and we have not identified specific geographic areas or times of year when 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 Southern Resident killer whale 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. As described under A3 in the delisting criteria, POPs are widely known to be of particular concern to marine mammals. Some studies document decreasing trends for bioaccumulated contaminants in Puget Sound harbor seals, including PCBs (Calambokidis et al. 1999, Ross et al. 2013) and one study indicates a decreasing trend in PCBs in killer whales from 1993-1995 and 2004 and 2006 (Krahn et al. 2007). In recent years, researchers have started collecting baseline information on emerging contaminants, such as flame retardants (PBDEs), in killer whales (Krahn et al. 2007; Mongillo 2012; Gockel and Mongillo 2013; Lundin et al. 2015). Many of the contaminant studies of killer whales rely on small sample sizes and additional work is needed to track trends in individual animals over time and to link physiological effects with different levels of various contaminants. Appendix A includes information on NMFS funding for research actions in the Recovery Plan, including action B.6.3, Assess the effects of contaminants.
- A4. As described under A4 in the delisting criteria, NMFS has taken several management actions to reduce vessel disturbance. New federal regulations were codified in 2011 to regulate vessel behavior to reduce impacts on the whales (76 Fed. Reg. 20870, April 14 2011). We have continued to work with our partners to promote voluntary guidelines (Be Whale Wise) and implement education programs. Previous guidelines and education programs have remained in place while some education programs have expanded. Two ESA Section 6 grants have been provided to assist WDFW in their enforcement efforts, and the Soundwatch Boater Education Program has continued to receive funding for their education and outreach programs, as well as their on-the-water monitoring efforts. The new vessel regulations are currently under evaluation to determine their effectiveness over the last five years. 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.

- B1. As described above under the B2 delisting criteria, the public display industry has not requested authorization to remove Southern Resident killer whales from the wild and NMFS has not authorized any live captures. Incidental take in fisheries is not currently a threat to Southern Resident killer whales, however some potentially harmful interactions do occur (Caretta et al. 2010; 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. NMFS is currently evaluating the impact of research activities such as satellite tagging, which has been suspended following the death of L95 who was previously tagged.

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 reproduction and survival of Southern Residents.

- C1. As described above for C1 under the delisting criteria, we have not identified infectious disease as a limiting factor for the Southern Resident killer whale population. We do not, however, have sufficient information to ensure that disease is not affecting the population. In a review of 18 killer whale strandings since 2005, disease was not identified as a cause of death for the one confirmed Southern Resident (Gaydos and Raverty 2010). Two killer whales (one offshore and one transient) were diagnosed with bacterial infections and the cause of death for about half of all strandings was unknown. Additional monitoring of the population and thorough examinations of any stranded killer whales are needed to increase our understanding of how diseases are affecting the Southern Residents. A review of killer whale strandings along the West Coast is currently underway.

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.

- D1. Regulations are under evaluation as part of the Puget Sound Partnership program described above under D2 in the delisting criteria. Through ESA consultations, NMFS will evaluate the effects of Federal actions associated with regulations and standards for harmful contaminants on the Southern Resident killer whales.
- D2. NMFS has taken several management actions to reduce vessel disturbance, the most significant of which has been implementing mandatory regulations in May of 2011 (76 Fed. Reg. 20870, April 14, 2011). NMFS has also continued to work with partners to educate boaters as well as monitor vessel behavior and enforce the regulations on the water. These actions are described above under A4 of the delisting criteria.

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?

No, not all of the threats criteria for Factor E have been met. Additional information is necessary to evaluate the distribution, habitat use, and potential risks to the Southern Residents in the coastal portion of their range. NMFS, along with partners, has made significant progress on other criteria. 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.

- E1. A description of ongoing oil spill prevention efforts are include above under E2 of the delisting criteria.
- E2. As described above under E3 of the 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, Continue the annual census, from the Recovery Plan and cost information is included in Appendix A.
- 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 3.5.1, as well as in the 10-year report and on the NWFSC website at:
<https://www.nwfsc.noaa.gov/research/divisions/cb/ecosystem/marinemammal/research.cfm>.
- E4. The research programs underway to increase our knowledge of coastal distribution and habitat use are described above under E4 in the delisting criteria. Support for research actions in the Recovery Plan, including B.1.1, Determine distribution and movements in outer coastal waters, is included in Appendix B.

4.0 RESULTS

4.1 Updated Information and Current Species Status

The 2008 Recovery Plan for Southern Resident Killer Whales includes the best available information on Southern Resident killer whale biology, habitat, and threats. This information is reflected in the recovery criteria taken from the Recovery Plan. The latest NMFS population viability analysis and Center for Whale Research Census for the Southern Residents contains updated information. There is an active research program and researchers have completed new papers since we completed the Recovery Plan and 2011 5-year review. Additional papers related to the major threats are provided below, although this list is not meant to be comprehensive of all research done on killer whales worldwide. Recent biological opinions also incorporate the latest information from scientific papers and unpublished data. This new information increases our knowledge, but does not change the status of the species or change the magnitude or imminence of the threats since the listing.

Genetics

- Foote, A. D. 2012. Investigating ecological speciation in non-model organisms: a case study of killer whale ecotypes. *Evolutionary Ecology Research*. Volume 14, pages 447 to 465.
- Foote, A.D., P. A. Morin, J. W. Durban, R. L. Pitman, P. Wade, E. Willerslev, M. T. P. Gilbert, and R. R. da Fonseca. 2010. Positive selection on the killer whale mitogenome. *The Royal Society Publishing, Biology Letters*. Volume 7, pages 116 to 118.
- Foote AD, Morin PA. 2016. Genome-wide SNP data suggest complex ancestry of sympatric North Pacific killer whale ecotypes. *Heredity* 117:316-325.
- Foote AD, Vijay N, Avila-Arcos MC, Baird RW, Durban JW, Fumagalli M, Gibbs RA, Hanson MB, Korneliussen TS, Martin MD, et al. 2016. Genome-culture coevolution promotes rapid divergence of killer whale ecotypes. *Nature Communications* 7.
- Ford, M. J., M. B. Hanson, J. Hempelmann, K. L. Ayres, C. K. Emmons, G. S. Schorr, R. W. Baird, K. C. Balcomb, S. K. Wasser, K. M. Parsons, K. Balcomb-Bartok. 2011. Inferred Paternity and Male Reproductive Success in a Killer Whale (*Orcinus orca*) Population. *Journal of Heredity*. Volume 102 (Issue 5), pages 537 to 553.
- Morin, P. A., F. I. Archer, A. D. Foote, J. Vilstrup, E. E. Allen, P. Wade, J. Durban, K. Parsons, R. Pitman, L. Li, P. Bouffard, S. C. Abel Nielsen, M. Rasmussem, E. Willerslev, M. T. P. Gilbert, and T. Harkins. 2010. Complete mitochondrial genome phylogeographic analysis of killer whales (*Orcinus orca*) indicates multiple species. *Genome Research*. Volume 20, pages 908 to 916.
- Morin PA, Parsons KM, Archer FI, Avila-Arcos MC, Barrett-Lennard LG, Dalla Rosa L, Duchene S, Durban JW, Ellis GM, Ferguson SH, et al. 2015. Geographic and temporal dynamics of a global radiation and diversification in the killer whale. *Molecular Ecology* 24:3964-3979.
- Parsons, K., J. Durban, A. Burdin, V. Burkanov, R. Pitman et al. 2013. Geographic patterns of genetic differentiation among killer whales in the northern Pacific. *Journal of Heredity*. doi: 10.1093/jhered/est037.
- Riesch, R., L. G. Barrett-Lennard, G. M. Ellis, J. K. B. Ford and V. B. Deecke, 2012 Cultural traditions and the evolution of reproductive isolation: ecological speciation in killer whales? *Biological Journal of the Linnean Society* 106: 1- 17

Population Dynamics

- Beck, S., S. Kuningas, R. Esteban and A. D. Foote. 2011. The influence of ecology on sociality in the killer whale (*Orcinus orca*). *Behavioral Ecology*.

Ward, E. J., B. X. Semmens, E. E. Holmes, and K. C. Balcomb. 2011. Effects of multiple levels of social organization on survival and abundance. *Conservation Biology*. Volume 25, pages 350 to 355.

Contaminants and Health

Alonso, M. B., A. Azevedo, J. P. M. Torres, P. R. Dorneles, E. Eljarrat, D. Barceló, J. Lailson Brito Jr., and M. Olaf. 2014. Anthropogenic (PBDE) and naturally-produced (MeO-PBDE) brominated compounds in cetaceans— A review. *Science of the Total Environment*. Volume 481, pages 619 to 634.

Ayres, K. L., R. K. Booth, J. Hempelmann, K. Koski, C. K. Emmons, R. W. Baird, K. Balcomb-Bartok, M. B. Hanson, M. J. Ford, S. K. Wasser. 2012. Distinguishing the Impacts of inadequate Prey and Vessel Traffic on an Endangered Killer Whale (*Orcinus orca*) Populations. *PLoS ONE*.

Buckman, A. H., N. Veldhoen, G. Ellis, J. K. B. Ford, C. C. Helbing, and P. S. Ross. 2011. PCB-Associated Changes in mRNA Expression in Killer Whales (*Orcinus orca*) from the NE Pacific Ocean. *Environmental Science and Technology*. Volume 45, pages 10194 to 10202.

Fearnbach, H., J. Durban, D. Ellifrit, and K. Balcomb. 2011. Size and long-term growth trends of endangered fish-eating killer whales. *Endangered Species Research*. Volume 13, pages 173 to 180.

Gockel, C. K. and T. Mongillo. 2013. Potential Effects of PBDEs on Puget Sound and Southern Resident Killer Whales: A report on the Technical Workgroups and Policy Forum. U.S. E.P.A. and NMFS. 20 Pages.
http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/killer_whale/rpi_environmental_contaminants.html

Lundin, J. I., R. L. Dills, G. M. Ylitalo, M. B. Hanson, C. K. Emmons, G. S. Schorr, J. Ahmad, J. A. Hempelmann, K. M. Parsons, and S. K. Wasser. 2015. Persistent Organic Pollutant Determination in Killer Whale Scat Samples: Optimization of a Gas Chromatography/Mass Spectrometry Method and Application to Field Samples. *Arch Environ Contam Toxicol*. Volume 70, pages 9 to 19.

Mongillo T. M., E. E. Holmes, D. P. Noren, G. R. VanBlaricom, A. E. Punt, S. M. O'Neill, G. M. Ylitalo, M. B. Hanson, and P. S. Ross. 2012. Predicted polybrominated diphenyl ether (PBDE) and polychlorinated biphenyl (PCB) accumulation in southern resident killer whales. *Mar Ecol Prog Ser*. Volume 453, pages 263 to 277

Mongillo, T. M., G. M. Ylitalo, L. D. Rhodes, S. M. O'Neill, D. P. Noren, and M. B. Hanson. 2016. Exposure to a mixture of toxic chemicals: Implications for the health of endangered Southern Resident killer whales. U.S. Dept. Commer., NOAA Tech. Memo. NMFSNWFSC-135, 107 p. doi:10.7289/V5/TM-NWFSC-135

- Noren, D. P. and J. A. Mocklin. 2011. Review of cetacean biopsy techniques: factors contributing to successful sample collection and physiological and behavioral impacts. *Marine Mammal Science*. Volume 28 (Issue 1), pages 154 to 199.
- Raverty, S. 2016. Final Report AHC Case: 14-5855. British Columbia Ministry of Agriculture, Animal Health Centre.
http://www.westcoast.fisheries.noaa.gov/publications/protected_species/marine_mammals/killer_whales/j32necropsy.pdf
- Raverty, S. 2016. Final Report AHC Case: 16-1760. British Columbia Ministry of Agriculture, Animal Health Centre.
http://www.westcoast.fisheries.noaa.gov/publications/protected_species/marine_mammals/killer_whales/195necropsy.pdf
- Raverty, S. and J. Gaydos. 2014. Killer whale necropsy and disease testing protocol. 82 pages.
- Ross, P. S., N. Marie, D. Lambourn, N. Dangerfield, J. Calambokidis, and S. Jeffries. 2013. Declining concentrations of persistent PCBs, PBDEs, PCDEs, and PCNs in harbor seals (*Phoca vitulina*) from the Salish Sea. *Progress in Oceanography*. Volume 115, pages 160 to 170.
- Sericano J. L., T. L. Wade, S. T. Sweet, J. Ramirez, and G.G. Lauenstein. 2014. Temporal trends and spatial distribution of DDT in bivalves from the coastal marine environments of the continental United States, 1986-2009. *Marine Pollution Bulletin*. Volume 81, pages 303 to 316. doi:10.1016/j.marpolbul.2013.12.049

Prey

- Adams, J., Kaplan, I.C., Chasco, B., Marshall, K.N., Acevedo-Gutiérrez, A., and Ward, E.J. 2016. A century of Chinook salmon consumption by marine mammal predators in the Northeast Pacific Ocean. *Ecol. Inform.* **34**: 44–51
- Chasco B., Kaplan I.C., Ward E.J., Thomas A., Acevedo-Gutierrez A., Noren D.P., Ford M.J., Hanson M.B., Scordino J., Jeffries S.J., Pearson S.F., Marshall K.N. (in press) Estimates of Chinook salmon consumption in Washington State inland waters by four marine mammal predators from 1970-2015. *Canadian Journal of Fisheries and Aquatic Sciences*.
- Ford, M. J., J. Hempelmann, M. B. Hanson, K. L. Ayers, R. W. Baird, C. K. Emmons, J. I. Lundin, G. S. Schorr, S. K. Wasser, L. K. Park. 2016. Estimation of a Killer Whale (*Orcinus orca*) Population's Diet Using Sequencing Analysis of DNA from Feces. *PLoS One*. January 6, 2016. 14 pages.
- Hilborn, R., S. P. Cox, F.M.D. Gulland, D. G. Hankin, N. T. Hobbs, D. E. Schindler, and A.W. Trites. 2012. The Effects of Salmon Fisheries on Southern Resident Killer Whales: Final Report of the Independent Science Panel.

- Strange, E.L. 2016. Assessing Southern Resident Killer Whale (*Orcinus orca*) Prey Abundance: The Effects of Chinook Salmon (*Oncorhynchus tshawytscha*) Ocean Fishery Reductions and Related Hatchery Production. California State University. Master's Thesis. 66 pages.
- Ward, E. J., M. J. Ford, R. G. Kope, J. K. Ford, A. Velez-Espino, C. K. Parken, L. LaVoy, M. B. Hanson, K. C. Balcomb. 2013. Estimating the impacts of Chinook salmon abundance and prey removal by ocean fishing on Southern Resident killer whale population dynamics. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-123, 71 pages.
- Williams, R., M. Krkošek, E. Ashe, T. A. Branch, S. Clark, P. S. Hammond, E. Hoyt, D. P. Noren, D. Rosen, and A. Winship. 2011. Competing Conservation Objectives for Predators and Prey: Estimating Killer Whale Prey Requirements for Chinook Salmon. PLoS One. Volume 6 (Issue 11).

Energetics

- Noren, D. P. 2011. Estimated field metabolic rates and prey requirements of resident killer whales. Marine Mammal Science. Volume 27 (Issue 1), pages 60 to 77.
- O'Neill, S. M., G. M. Ylitalo, and J. E. West. 2014. Energy content of Pacific salmon as prey of northern and southern resident killer whales. Endangered Species Research. Volume 25, pages 265 to 281.
- Williams, R., M. Krkošek, E. Ashe, T.A. Branch, S. Clark, P.S. Hammon, E. Hoyt, D. P. Noren, D. Rosen, and A. Winship. 2011. Competing conservation objectives for predators and prey: estimating killer whale prey requirements for Chinook salmon. PLoS ONE 6(11): e26738.

Distribution and Habitat

- Center for Whale Research (CWR). 2016. Narrative Contract Report for Item T0002 SRKW Annual Census as of July 1, 2016.
- Department of the Navy. 2015. Marine Species Monitoring Report for the U.S. Navy's Northwest Training Range Complex- Annual Report 2 May 2014 to 1 May 2015. U.S. Pacific Fleet, Pearl Harbor, Hawaii. Final July 1, 2015.
- Hanson, M. B., C. K. Emmons, E. J. Ward, J. A. Nystuen, and M. O. Lammers. 2013. Assessing the coastal occurrence of endangered killer whales using autonomous passive acoustic recorders. Journal of the Acoustical Society of America. Volume 134, pages 3486 to 3495.
- Holt, M. M., D. P. Noren, C. K. Emmons. 2012. An investigation of sound use and behavior in a killer whale (*Orcinus orca*) population to inform passive acoustic monitoring studies. Marine Mammal Science. doi:DOI: 10.1111/j.1748-7692.2012.00599.x
- Noren, D. P. and D. D. W. Hauser. 2016. Surface-Based Observation Can Be Used to Assess Behavior and Fine-Scale Habitat Use by an Endangered Killer Whale (*Orcinus orca*) Population. Aquatic Mammals. Volume 42 (Issue 2), pages 168 to 183.

Riera, A., J. K. B. Ford, J. Hildebrand and N. Chapman, 2011 Acoustic monitoring of killer whale populations off the west coast of Vancouver Island. *Journal of the Acoustic Society of America* 129: 2607

Vessel Interactions and Noise Effects

Bassett, C., B. Polagye, M. M. Holt, and J. Thomson. 2012. A vessel noise budget for Admiralty Inlet, Puget Sound, WA (USA). *Journal of the Acoustical Society of America* Volume 132, Issue 6. DOI: 10.1121/1.4763548.

Holt, M. M., D. P. Noren, and C. K. Emmons. 2011. Effects of noise levels and call types on the source levels of killer whale calls. *Journal of the Acoustical Society of America*. Volume 130 (Issue 5), pages 3100 to 3106. doi:DOI: 10.1121/1.3641446

Holt, M.M., D. P. Noren, and C.K. Emmons. 2012. Does vessel noise affect the use of sound by foraging *Orcinus orca* (killer whales)? In: Anthony Hawkins and Arthur N. Popper, Eds. *The Effects of Noise on Aquatic Life*, pages 327 to 330.

Holt, M. M., D. P. Noren, R. C. Dunkin, and T. M. Williams. 2015. Vocal performance affects metabolic rate in dolphins: implications for animals communicating in noisy environments. *The Journal of Experimental Biology*. Volume 218, pages 1647 to 1654.

Houghton, J., M. M. Holt, D. A. Giles, M. B. Hanson, C. K. Emmons, J. T. Hogan, T. A. Branch, and G. R. VanBlaricom. 2015. The Relationship between Vessel Traffic and Noise Levels Received by Killer Whales (*Orcinus orca*). *PLoS One*. DOI:10.1371/journal.pone.0140119

Lachmuth, C. L., L. G. Barrett-Lennard, D.Q. Steyn, and W. K. Milsom. 2011. Estimation of southern resident killer whale exposure to exhaust emissions from whale-watching vessels and potential adverse health effects and toxicity thresholds. *Marine Pollution Bulletin*. Volume 62 (Issue 4), pages 792 to 805.

Noren D.P., Holt M.M, Dunkin R.C., Thometz N.M., Williams T.M. (in press) Comparative and cumulative energetic costs of odontocete responses to anthropogenic disturbance. *Proceedings of Meetings on Acoustics*.

Noren, D. P., M. M. Holt, R. C. Dunkin, T. M. Williams. 2013. The metabolic cost of communicative sound production in bottlenose dolphins (*Tursiops truncatus*). *Journal of Experimental Biology*. Volume 216, pages 1624 to 1629.

Russell, S. and Schneidler, M. In press. The U.S. Whale Watching Industry of the Greater Puget Sound: A Description and Baseline Analysis. U.S. Dept. of Comm., NOAA Tech. Memo. NMFS-NWFSC-89, 59 pages.

Seely, Elizabeth. 2015. Final 2015 Soundwatch Program Annual Contract Report. The Whale Museum. 45 pages.

Senigaglia V., Christiansen F., Bejder L., Gendron D., Lundquist D., Noren D.P., Schaffar A., Smith J.C., Williams R., Martinez E., Stockin K., Lusseau D. 2016. Meta-analyses of whale-watching impact studies: comparisons of cetacean responses to disturbance. *Marine Ecology Progress Series*. Volume 542, pages 251 to 263.

Veirs, S., V. Veirs, and J. D. Wood. 2015. Ship noise extends to frequencies used for echolocation by endangered killer whales. *PeerJ*. DOI 10.7717/peerj.1657

Recovery

Fisheries and Oceans Canada. 2016. Action Plan for the Northern and Southern Resident Killer Whale (*Orcinus orca*) in Canada [Proposed]. Species at Risk Act Action Plan Series. Fisheries and Oceans Canada, Ottawa. iii + 32 pages.

Marshall, K. N., Stier, A. C., Samhour, J. F., Kelly, R. P., and E. J. Ward. 2015. Conservation challenges of predator recovery. *Conserv. Lett.* Available from <http://onlinelibrary.wiley.com/doi/10.1111/conl.12186/full> [accessed 12 March 2016].

NMFS. 2011. Southern Resident Killer Whales 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Northwest Regional Office. Seattle, WA. 70 pages.

NMFS. 2012. Endangered Species Act Biological Opinion and Not Likely to Aversely Affect Determination for Continuing Operation of the Pacific Coast Groundfish Fishery. National Marine Fisheries Service, Northwest Region. NMFS Tracking Number NWR-2012-876.

NMFS. 2014. Consultation on Remand for Operation of the Federal Columbia River Power System. National Marine Fisheries Service, Northwest Region. NMFS Tracking Number NWR-2013-9562.

NMFS. 2015. Endangered Species Act Section 7(a)(2) Supplement to the biological Opinion for the Idaho Water Quality Standards for Toxic Substances. National Marine Fisheries Service, Northwest Region. NMFS Tracking Number 2014-1874.

NMFS. 2016b. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. National Marine Fisheries Service, West Coast Region. NMFS Tracking Number F/WCR-2016-4914.

NFWF. 2015. 2015 Killer Whale Research and Conservation Program Grant Slate. National Fish and Wildlife Foundation. <http://www.nfwf.org/killerwhales/Documents/killerwhalegrants15-1027.pdf>

Puget Sound Partnership. 2016. The 2016 Action Agenda for Puget Sound. Olympia, Washington. 220 pages. www.psp.wa.gov

4.2 Synthesis

Southern Resident killer whales were listed as endangered in 2005. In the 10 years since the listing, and in years prior to the listing, a variety of Federal, state, non-profit, and local organizations have implemented conservation actions to benefit the whales, their prey, and the ecosystem. The Final 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. It will take many years to fill key data gaps and assess the effectiveness of ongoing recovery actions for the whales, salmon, and their habitat, and to observe significant increases in the Southern Resident 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. We still have much to learn. Additional research is needed to increase our knowledge of the whales' coastal range and habitat use, where and when the whales may be food limited, the health status of individuals, physiological effects from contaminant loads, and how sound impacts the whales. We must continue population assessments, prey and vessel studies, and contaminant monitoring to evaluate our impacts on the whales and identify new and better ways to address threats.

Since completing the Recovery Plan, NMFS has prioritized actions to address the threats with highest potential for mitigation: prey availability, oil spill response, and reducing vessel impacts (Table 2.1). Progress has also been made on additional threats such as contaminants. Several threats criteria have been met, but many will take years of research and dedicated conservation efforts to satisfy. Salmon recovery is a high priority on the West Coast and there are numerous actions underway to address threats and monitor populations. Recovery of depleted salmon populations is complex, including finalizing and implementing recovery plans, and seeing subsequent population increases is a long-term process. NMFS, along with our state and academic partners, has successfully developed an oil spill response plan for killer whales; however, we still have additional work to prepare for a major spill event. The 2011 vessel regulations are an important step to reduce disturbance from vessels. It will take time to evaluate the effectiveness of any new regulations in improving conditions for the whales. Even with progress toward minimizing the impacts of the threats, each of the threats still pose a risk to the survival and recovery of the whales.

At the time of listing in 2005, there were 88 whales in the population and at the time of this report there are 78. Population growth has varied during this time with both increasing and decreasing years. 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 even prior to 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. Considering the status and continuing threats, the Southern Resident killer whales remain in danger of extinction. Therefore, the recommended classification for Southern Resident killer whales is to remain the same: Endangered.

4.2.1 Recommended Classification:

- ☐ **Downlist to Threatened**
- ☐ **Uplist to Endangered**
- ☐ **Delist** (*Indicate reasons for delisting per 50 CFR 424.11*):
 - ☐ *Extinction*
 - ☐ *Recovery*
 - ☐ *Original data for classification in error*
- ☒ **No change is needed**

3.5.4 New Recovery Priority Number: Number One

5.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Recovery of Southern Resident killer whales depends upon implementation of a variety of actions detailed in the Recovery Plan, as well as the full participation and support of all Federal, state, and private stakeholders. These actions should be pursued aggressively to prevent the extinction of this species, and funding decisions should give highest priority to actions that will contribute directly to mitigating impacts and research that will inform management and conservation.

There is a comprehensive research section in the Recovery Plan, and research actions are highlighted in the Species in the Spotlight profile and the 10-year report. Many research projects are identified as Priority 1, actions that must be taken to identify those 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. There are also Priority 1 actions to fill key data gaps to inform management of threats, protect habitat, and identify risks. Priority 1 research actions include determining distribution and movements in coastal waters, causes of mortality, metabolic rates, responses to changes in oceanographic conditions, and risk of inbreeding. The 10-year report and Species in the Spotlight Action Plan also outline priority actions to be focused on over the next 5 to 10 years.

In the next 10 years, particular priority should be focused on the following management and research actions. Priority actions are listed in Table 4.1 and described in more detail in the 10-year report and the Species in the Spotlight Priority Actions report.

Table 4.1 Priority actions for Southern Resident killer whale recovery to be taken over the next 10 years.

	Prey Availability	Pollution	Vessel Effects	Health Assessment
Science & Research	<ul style="list-style-type: none"> • Study competition between other salmon predators including seals and sea lions, Northern Resident killer whales, and fisheries • Continue efforts to identify salmon stocks that are most important to the whales • Continue research on whale health related to diet • Continue to study what whales eat in the winter • Investigate inter-year variability in killer whale diet • Investigate the role of hatchery fish in whale diet • Estimate ocean distributions of Chinook salmon 	<ul style="list-style-type: none"> • Monitor levels of new and emerging contaminants in the whales • Test and refine models to predict future contaminant loads • Investigate whether contaminants have direct impacts on health and reproduction 	<ul style="list-style-type: none"> • Investigate whether noise and vessels prevent whales from foraging efficiently • Measure the impacts of behaviors change due to vessel presence and noise • Conduct field studies to evaluate effectiveness of new vessel regulations • Quantify sources of human-generated noise throughout the whale's range and assess their impacts 	<ul style="list-style-type: none"> • Continue and expand photogrammetric studies to monitor body condition • Combine health information for individuals from data collected to date (biopsies, feces, imagery, etc.) • Conduct new nutritional studies and breath analyses to understand conditions that may contribute to killer whale mortality • Expand stranding investigations and disease testing
Conservation & Management	<ul style="list-style-type: none"> • Continue to evaluate relationships between salmon abundance and whale health and minimize effects of actions that reduce salmon abundance • Target critical prey in the prioritization of recovery actions that will contribute most to the prey base of the whales 	<ul style="list-style-type: none"> • Evaluate and minimize effects of actions that increase contaminants in the whales and their prey • Support oil spill prevention • Continued readiness in the event of a potentially catastrophic oil spill 	<ul style="list-style-type: none"> • Continue to enforce and evaluate vessel regulations • Continue to educate boaters and promote responsible whale watching 	<ul style="list-style-type: none"> • Use health assessment and stranding investigation results to help prioritize recovery actions

	Population Structure	Demographics	Winter Distribution
Science & Research	<ul style="list-style-type: none"> • Continue to collect and analyze data to inform killer whale taxonomy and breeding patterns • Collect data needed to estimate historical abundance 	<ul style="list-style-type: none"> • Continue to monitor population size and response to changes in salmon abundance • Improve our estimates of carrying capacity of the environment for the whales • Study how the population responds to seasonal changes in prey abundance and competition with other salmon predators 	<ul style="list-style-type: none"> • Address many questions about their life during the winter (diet, behavior, threats) to assess which risk factors may be impacting the whales in this portion of their range
Conservation & Management	<ul style="list-style-type: none"> • Use taxonomic and genetic information to assess the status of population and recovery criteria during reviews of listing status and in response to petitions 	<ul style="list-style-type: none"> • Conduct periodic reviews under the ESA to assess progress toward recovery goals 	<ul style="list-style-type: none"> • Evaluate expanding critical habitat areas to include waters along the west coast where they range

6.0 ADDITIONAL REFERENCES

- Balcomb, K. C. 2015. A Report on J39 Fishery Interaction from 1 August 2015 through 20 December 2015. Center for Whale Research. 5 pages.
- Calambokidis, J., S. Jeffries, P. S. Ross, and M. Ikonomu. 1999. Temporal trends in Puget Sound harbor seals. Final Report for the U.S. Environmental Protection Agency and Puget Sound Water Quality Action Team, Cascadia Research, Olympia, Washington.
- Carretta, J. V., K. A. Forney, M. S. Lowry, J. Barlow, J. Baker, D. Johnston, B. Hanson, R. L. Brownell Jr., J. Robbins, D. K. Mattila, K. Ralls, M. M. Muto, D. Lynch, and L. Carswell. 2010. U.S. Pacific Marine Mammal Stock Assessments: 2009. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-453. 336 pages.
- Durban, J., H. Fearnbach, D. Ellifrit, and K. Balcomb. 2009. Size and body condition of Southern Resident killer whales. Contract AB133F08SE4742 report to the Northwest Regional Office, National Marine Fisheries Service, Seattle, WA. 22 pages.
- Ford, J. K. B., G. M. Ellis, P. F. Olesiuk, and K. C. Balcomb. 2010. Linking killer whale survival and prey abundance: food limitation in the oceans' apex predator? *Biology Letters Population Ecology*. Volume 6, pages 139 to 142.
- Gaydos, J. K., K. C. Balcomb, III, R. W. Osborne, and L. Dierauf. 2004. Evaluating potential infectious disease threats for southern resident killer whales, *Orcinus orca*: a model for endangered species. *Biological Conservation*. Volume 117, pages 253 to 262.
- Gaydos, J. K. and S. Raverty. 2010. Killer Whale Strandings: Alaska, British Columbia, California, Hawaii, and Washington 2005-2010. Contract Report to NMFS, Seattle, WA.
- Hanson, M. B., D. P. Noren, T. F. Norris, C. A. Emmons, T. Guy, and J. Zamon. 2008a. Pacific Ocean killer whale and other marine mammals distribution survey, March 2006 (PODs 2006) conducted aboard the NOAA ship McArthur II. Unpubl. Rept, NWFSC, Seattle, WA.
- Hanson, M. B., D. P. Noren, T. F. Norris, C. A. Emmons, M. M. Holt, T. Guy, and J. Zamon. 2008b. Pacific Ocean killer whale and other cetaceans distribution survey, May 2007 (PODs 2007) conducted aboard the NOAA ship McArthur II. Unpubl. Rept, NWFSC, Seattle, WA.
- Hanson, M. B., D. P. Noren, T. F. Norris, C. A. Emmons, M. M. Holt, E. Phillips, and J. Zamon. 2009a. Pacific Orca Distribution Survey (PODS) conducted aboard the NOAA ship McArthur II in March 2008. (STATE DEPT. CRUISE NO:2008-019) Unpubl. Rept, NWFSC, Seattle, WA.
- Hanson M. B., C. K. Emmons, J. A. Nystuen, and M. O. Lammers. 2009b. Using moored passive acoustic recorders to assess seasonal occurrence and movements of southern resident killer whales and other cetaceans in the coastal waters of Washington State. Abstract, 157th

Meeting of the Acoustical Society of America, May 18-22, 2009, Portland, Oregon.

- Hanson, M. B., R. W. Baird, J. K. Ford, J. Hempelmann, D. M. Van Doornik, J. R. Candy, C. K. Emmons, G. S. Schorr, B. Gisborne, K. L. Ayers, S. K. Wasser, K. C. Balcomb III, K. Balcomb, J. G. Sneva, and M. J. Ford. 2010. Species and Stock Identification of Prey Selected by Endangered "Southern Resident" Killer Whales in Their Summer Range. *Endangered Species Research*. Volume 11, pages 69 to 82.
- Krahn, M. M., M. J. Ford, W. F. Perrin, P. R. Wade, R. P. Angliss, M. B. Hanson, B. L. Taylor, G. M. Ylitalo, M. E. Dahlheim, J. E. Stein, and R. S. Waples. 2004. 2004 status review of southern resident killer whales (*Orcinus orca*) under the Endangered Species Act. NOAA Technical Memorandum NMFS-NWFSC-62, U.S. Department of Commerce, Seattle, Washington.
- Krahn, M. M., M. B. Hanson, R. W. Baird, R. H. Boyer, D. G. Burrows, C. E. Emmons, J. K. B. Ford, L. L. Jones, D. P. Noren, P. S. Ross, G. S. Schorr, and T. K. Collier. 2007. Persistent organic pollutants and stable isotopes in biopsy samples (2004/2006) from Southern Resident killer whales. *Marine Pollution Bulletin*. Volume 54, pages 1903 to 1911.
- Lusseau, D., Bain, D. E., Williams, R., Smith, J. C. 2009. Vessel traffic disrupts the foraging behavior of southern resident killer whales *Orcinus orca*. *Endangered Species Research*. Volume 6, pages 211 to 221.
- NMFS (National Marine Fisheries Service). 2006. Southern Resident Killer Whale Research Plan. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. 22 pages.
- NMFS. 2008a. Recovery Plan for Southern Resident Killer Whales (*Orcinus orca*). National Marine Fisheries Service, Northwest Region, Seattle, Washington.
- NMFS. 2008b. Endangered Species Act Section 7(a)(2) Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on the Approval of Revised Regimes under the Pacific Salmon Treaty and the Deferral of Management to Alaska of Certain Fisheries Included in those Regimes. NMFS, Northwest Region. December 22, 2008. 373 pages.
- NMFS. 2008c. Effects of the 2008 Pacific Coast Salmon Plan Fisheries on the Southern Resident Killer Whale Distinct Population Segment (*Orcinus orca*) and their Critical Habitat. Endangered Species Act – Section 7 Consultation, Biological Opinion. Consultation conducted by National Marine Fisheries Service, Northwest Region. Issued by Frank Lockhart, for D. Robert Lohn, Regional Administrator. NMFS Tracking Number F/NWR/2008/02612.
- NMFS. 2008d. Effects of the 2008 U.S. Fraser Panel Fisheries on the Southern Resident Killer Whale (*Orcinus orca*) Distinct Population Segment (DPS). Endangered Species Act – Section 7 Consultation, Biological Opinion. Consultation conducted by National Marine

Fisheries Service, Northwest Region. Issued by Donna Darm, for D. Robert Lohn, Regional Administrator. NMFS Tracking Number F/NWR/2008/04296.

- NMFS. 2009. Endangered Species Act Section 7(a)(2) Consultation Biological Opinion. Consultation biological opinion on the Effects of the 2009 U.S. Fraser Panel Fisheries on the Southern Resident Killer Whale (*Orcinus orca*) Distinct Population Segment. National Marine Fisheries Service, Northwest Region. F/NWR/2009/03643. July 16, 2009. 81 pages.
- Olesiuk, P. F., G. M. Ellis, and J. K. Ford. 2005. Life history and population dynamics of northern resident killer whales (*Orcinus orca*) in British Columbia. DFO Canadian Science Advisory Secretariat Research Document 2005/045.
- Ward, E. J., E. E. Holmes, and K. C. Balcomb III. 2009. Evidence of reproductive senescence and prey limitation in killer whales. *Journal of Animal Ecology*. Volume 46, pages 632 to 640.
- Washington Department of Ecology (Ecology). 2009. Spill Prevention, Preparedness, and Response Program 2007–2008 Report. January 2009. WDOE Publication: 09-08-003. Volume 11 (Issue 1), 19 pages.
- Williams, R., D. Lusseau, and P.S. Hammond. 2006. Estimating relative energetic costs of human disturbance to killer whales (*Orcinus orca*). *Biological Conservation*: Volume 33 (Issue 3) December 2006, pages 301 to 311.

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

Current Classification: Endangered


Recommendation resulting from the 5-Year Review:

- ☐ Downlist to Threatened
- ☐ Uplist to Endangered
- ☐ Delist
- ☒ 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 12/27/2016

APPENDIX A

Updated Implementation Schedule from the Recovery Plan
for Southern Resident Killer Whales (NMFS 2008a).

RECOVERY MEASURES AND COSTS (\$ Thousands)

Task No.	Task Description	Priority	Responsible Parties	Comments	FY11	FY12	FY13	FY14	FY15	FY16
1	Protect Southern Resident killer whales from factors causing decline									
1.1	Rebuild depleted populations of salmon and other prey to ensure an adequate food base for recovery of the Southern Residents			Many salmon recovery efforts and management programs are currently ongoing by a variety of agencies and stakeholders. It is possible that there could be additional salmon restoration costs identified based on recovery needs of Southern Resident killer whales; however, at this time 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						
1.1.1.2	Harvest management	2	NMFS, state/tribal/ local recovery initiatives, NGO, DFO	See 1.1						

Task No.	Task Description	Priority	Responsible Parties	Comments	FY11	FY12	FY13	FY14	FY15	FY16
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; (i.e., \$570 million estimated by PSP, \$182 million for PSAT 2005-2007) although these funds may not be sufficient. Additional costs which may be incurred to guide specific cleanup actions aimed at Southern Resident killer whales are shown below.						
1.2.1	Clean up contaminated sites and sediments			See 1.2						

Task No.	Task Description	Priority	Responsible Parties	Comments	FY11	FY12	FY13	FY14	FY15	FY16
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						

Task No.	Task Description	Priority	Responsible Parties	Comments	FY11	FY12	FY13	FY14	FY15	FY16
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									
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	35	43	30	30	35	30
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						

Task No.	Task Description	Priority	Responsible Parties	Comments	FY11	FY12	FY13	FY14	FY15	FY16
1.3.2	Continue to evaluate and improve voluntary whale-watching guidelines	2	NMFS, M3, Soundwatch, DFO, NGO, WWOANW	Update guidelines in alternate years	25					
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	25	18	12	12		
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		35				
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									

Task No.	Task Description	Priority	Responsible Parties	Comments	FY11	FY12	FY13	FY14	FY15	FY16
2.1.1	Prevent oil spills	1	USCG, WDOE, EC, industry associations	There are many ongoing oil spill programs including: Rescue Tug (1.44 million/yr) and ITOS (100K/yr)						
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 Contingency 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	FY11	FY12	FY13	FY14	FY15	FY16
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 consultations; 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	Washington State has ongoing invasives prevention program (2.5 million/yr)						

Task No.	Task Description	Priority	Responsible Parties	Comments	FY11	FY12	FY13	FY14	FY15	FY16
2.4.2	Eradicate existing populations of invasive species	3	WDFW, USFWS, NMFS, WDOA, ODEQ, DFO, industry associations	Washington State has ongoing invasives eradication program (3.5 million/yr)						
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		40	30	25	34	50	45
3.1.2	School programs	3	NGO, Tribes		25	25	15	20	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						

Task No.	Task Description	Priority	Responsible Parties	Comments	FY11	FY12	FY13	FY14	FY15	FY16
3.2	Expand information and education programs to reduce direct vessel interactions with Southern Resident killer whales									
3.2.1	Expand the on-water educational efforts of Soundwatch, M3, and enforcement agencies	2	NMFS, Soundwatch, 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, Soundwatch, M3, WDFW, DFO, CG	Costs are included under 1.3.1.1	34	1	17	17	12	12
3.2.3	Encourage land-based viewing of killer whales	3	TWM, Orca Relief, Liferforce, WSP, NGO	Update program in alternate years, Whale Trail program	7.5		1			10

Task No.	Task Description	Priority	Responsible Parties	Comments	FY11	FY12	FY13	FY14	FY15	FY16
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						
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						
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						

Task No.	Task Description	Priority	Responsible Parties	Comments	FY11	FY12	FY13	FY14	FY15	FY16
4	Respond to killer whales that are stranded, sick, injured, isolated, pose a threat to the public, or exhibit nuisance behaviors			It is not possible to estimate costs for stranding response. 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 NWMMSN is involved in ongoing stranding response and the advent of the Prescott stranding grant program has been instrumental in increasing NWMMSN capabilities to respond to all strandings including killer whales. NMFS contracted with UC Davis FY05-FY10 for \$65K 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						

Task No.	Task Description	Priority	Responsible Parties	Comments	FY11	FY12	FY13	FY14	FY15	FY16
4.2.3	Investigate strandings of dead killer whales	3	NMFS, NMMSN, DFO, VA	Cost for response to stranded killer whales in OR, CA	10			17	17	17
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					25	25
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						
5.2.2	Encourage public participation	3	NMFS, DFO, WDFW	1 year task to update plan						

Task No.	Task Description	Priority	Responsible Parties	Comments	FY11	FY12	FY13	FY14	FY15	FY16
5.3	Inter-jurisdictional enforcement cooperation and coordination	3	NMFS, DFO, WDFW							
				TOTALS	212	117	100	130	164	147
					TOTAL FY11-FY16			\$870		

RESEARCH AND MONITORING

Task No.	Task Description	Priority	Responsible Parties	Comments	FY11	FY12	FY13	FY14	FY15	FY16
A	Monitor status and trend of Southern Resident killer whales									
A.1	Continue the annual population census	2	CWR		81	88	89	90	91	93
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		129	140	110	203	203	213

Task No.	Task Description	Priority	Responsible Parties	Comments	FY11	FY12	FY13	FY14	FY15	FY16
B.1.2	Improve knowledge of distribution and movements in the Georgia Basin and Puget Sound	1	NWFSC, SWFSC, UW, TWM		73	35	36	37	40	32
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			26	20		2	15	61
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	FY11	FY12	FY13	FY14	FY15	FY16
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	Photogrammetry support (2016)	31	28	11	71	6	25
B.4.1	Assess the health of population members	2		Future costs TBD						
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	FY11	FY12	FY13	FY14	FY15	FY16
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	FY11	FY12	FY13	FY14	FY15	FY16
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				132	103	15	69	6	104
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	FY11	FY12	FY13	FY14	FY15	FY16
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			1				
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	FY11	FY12	FY13	FY14	FY15	FY16
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	FY11	FY12	FY13	FY14	FY15	FY16
B.9	Determine genetic relationships		NWFSC, DFO, WFDW, researchers		10					10
B.9.1	Determine paternity patterns in the Southern Residents	2		Costs included under B.9	40	23	3			10
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		79	39				
B.11	Research support and coordination	2	NWFSC		17	20	18	20	37	39
				TOTALS	619	497	282	492	398	587
					TOTAL FY11-FY16			\$2,875		