Southern Resident Killer Whales
(Orcinus orca)

5-Year Review:
Summary and Evaluation

Photo: NOAA Fisheries, Northwest Regional Office

National Marine Fisheries Service
Northwest Regional Office
Seattle, WA

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

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional or Headquarters Office: Northwest Regional Office–Donna Darm, Assistant Regional Administrator for Protected Resources, (206) 526-4489

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 Northwest Regional Office led the 5-year review and requested review by the Northwest Fisheries Science Center, Alaska Fisheries Science Center, and Office of Protected Resources. *The Recovery Plan for the Southern Resident Killer Whales (Orcinus orca),* completed in January 2008, was the primary document and resource for the information and data in this review.

1.3 Background:

1.3.1 Federal Register Notice citation announcing initiation of this review:

75 Fed. Reg. 17377, April 6, 2010 - Endangered and Threatened Species; Initiation of 5-year Review for Southern Resident Killer Whales

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
Advance Notice of Proposed Rulemaking: 72 Fed. Reg. 13464, March 22, 2007 -Protective Regulations for Killer Whales in the Northwest Region under the Endangered Species Act and Marine Mammal Protection Act

Proposed Protective Regulations: 74 Fed. Reg. 37674, July 29, 2009 - Protective Regulations for Killer Whales in the Northwest Region under the Endangered Species Act and Marine Mammal Protection Act

1.3.4 Review History:

This is the first, formal 5-year Review for Southern Resident killer whales.

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

Southern Resident killer whales have a recovery Priority Number of Three, based on criteria in the Recovery Priority Guidelines (55 Fed. Reg. 24296, June 15, 1990) that describes a high magnitude of threats, moderate recovery potential, and the potential for economic conflicts while implementing recovery actions. The Priority Number of Three for Southern Resident killer whales is based on a high magnitude of threat because of low population numbers and continuing threats to recovery, a moderate recovery potential based on uncertainty regarding most important threats, and presence of conflict, because implementing regulatory actions could involve restrictions on commercial fishing, contaminant discharge, and vessels.

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 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

__X_ **Yes,** go to section 2.1.2.
_____**No,** go to section 2.2.

2.1.2 Is the species under review listed as a DPS?

_X__ ***Yes****, go to section 2.1.3.*
____ ***No****, go to section 2.1.4*

2.1.3 Was the DPS listed prior to 1996?

____ ***Yes****, give date and go to section 2.1.3.1.*
_X__ ***No****, go to section 2.1.4.*

2.1.3.1 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 2.1.4.*
____ ***No****, go to section 2.1.3.2.*

2.1.3.2 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 2.1.4.*
____ ***No****, discuss how it is not consistent with the DPS policy and consider the 5-year review completed. Go to section 2.4., Synthesis.*

2.1.4 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 2.2, Recovery Criteria. If the new information indicates the DPS listing is no longer valid, consider the 5-year review completed, and go to section 2.4, Synthesis.*

__X__ ***No****, go to section 2.2., Recovery Criteria.*

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan[1] containing objective, measurable criteria?

_X__ ***Yes****, continue to section 2.2.2.*

____ ***No****, consider recommending development of a recovery plan or recovery criteria in section IV, Recommendations for Future Actions, and go to section 2.3., Updated Information and Current Species Status.*

2.2.2 Adequacy of recovery criteria.

[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.

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

_X__ **Yes,** go to section 2.2.2.2.
____ ***No****, go to section 2.2.3, and note why these criteria do not reflect the best available information. Consider developing recommendations for revising recovery criteria in section 4.0.*

2.2.2.2 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 2.2.3 may be sufficient to evaluate the species listing classification and no further analysis may be necessary.)*

_X__ ***Yes****, go to section 2.2.3.*
____ ***No****, go to section 2.2.3, and note which factors do not have corresponding criteria. Consider developing recommendations for revising recovery criteria in section 4.0.*

2.2.3 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 2.2.2.1. and 2.2.2.2., 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 2.4., Synthesis.*

Background

The Southern Resident killer whale DPS was listed as endangered under the Endangered Species Act (ESA) in 2005. In the listing, 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 the end of 2010 there were only 86 whales in this small population. Their small population size and social structure also put them at risk for a catastrophic event, such as an oil spill, that could impact the entire population. Table 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 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, NOAA 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

Although the population has been studied for more than 30 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 (NWFSC) developed a research plan (NMFS 2006) that informed the monitoring and research actions in the Recovery Plan. The NWFSC conducts research on the whales, partners with 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. In 2009, the NWFSC compiled recent research results and developed a Newsletter to provide new information to the public and stakeholder groups, such as the whale watch industry and their naturalists (Appendix A).

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. Actions to restore salmon populations on the West Coast 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.

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 FY 2003-FY 2007. An updated implementation plan is included as Appendix B. We have updated the cost information for management, monitoring, and research actions implemented in FY 2008-FY 2010 for this review. Projected costs for FY 2011- FY 2012 remain from the Recovery Plan. NMFS' funding represents the majority of the costs included in the implementation plan for FY 2003-FY 2010 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. We are 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 people can provide this type of information (http://www.nwr.noaa.gov/Marine-Mammals/Whales-Dolphins-Porpoise/Killer-Whales/Recovery-Implement/index.cfm). In implementing a recovery program, NMFS has prioritized actions to address the threats with the highest potential for mitigation- salmon recovery, oil spill response, and reducing vessel impacts (Table 1).

The West Coast community has been engaged in salmon recovery for many years and in recent years 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 www.nwr.noaa.gov/Salmon-Recovery-Planning/index.cfm. The Pacific Coastal Salmon Recovery Fund (PCSRF) was established by Congress in FY 2000 to protect, restore, and conserve Pacific salmon and steelhead populations and their habitats. Under the PCSRF, NMFS manages a program to provide funding to states and tribes of the Pacific Coast region – Washington, Oregon, California, Nevada, Idaho, and Alaska. 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: www.nwr.noaa.gov/Salmon-Recovery-Planning/PCSRF/Index.cfm. To monitor progress on salmon recovery, NMFS initiated 5-year reviews for 27 listed Evolutionarily Significant Units and Distinct Population Segments of Pacific salmon and steelhead (75 Fed. Reg. 13082, March 18, 2010).

To address the threat of pollution and contamination, NMFS has worked with The Puget Sound Partnership, a community effort of citizens, governments, tribes, scientists, and businesses working together to restore and protect Puget Sound. NMFS participated in efforts of the Puget Sound Partnership to develop a strategy for cleaning up, restoring, and protecting Puget Sound by 2020. In 2009, the Partnership released an 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 2009). One of the actions identified in the Action Agenda is to "Implement the southern resident killer whale plan and continue to prioritize and identify actionable recovery measures with assignments and implementation timelines." For more information on efforts to address pollution and contaminants, please visit http://www.psp.wa.gov/.

NMFS has also coordinated with the U.S. Coast Guard, Washington Department of Fish and Wildlife (WDFW), and the Department of Fisheries and Oceans, Canada (DFO) to evaluate the need for regulations or areas with vessel restrictions as described in the Recovery Plan. Current voluntary guidelines are in place regarding vessel activity around the whales, but a vessel monitoring program has documented persistent violations of these guidelines for many years (Koski 2010). In March 2007, we published an Advance Notice of Proposed Rulemaking (72 Fed. Reg. 13464) to gather public input on whether and what type of regulation might be necessary to reduce vessel effects on Southern Residents. Based on public comments on the ANPR and new scientific information, we published a draft Environmental Assessment (EA) under the National Environmental Policy Act (NEPA) and proposed regulations in July 2009 (74 Fed. Reg. 37674) and held three public meetings. The proposed rule included three elements: 1) a prohibition on approaching killer whales within 200 yards, 2) a no-go zone prohibiting vessels from entering a 6 square mile area along the west side of San Juan Island from May 1-September 30, and 3) a prohibition on parking in the path of the whales. NMFS received a large number of comments on the proposed rule and is currently considering the comments and new information to develop a final rule.

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. 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, which can be found at http://rrt10nwac.com/NWACP/Default.aspx.

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).
- NMFS developed a high school level curricula on killer whale recovery aligned with state learning requirements (www.nwr.noaa.gov/upload/HS-orca.pdf).

Stranded killer whales provide valuable opportunities for us to learn about the status and threats to the Southern Resident killer whales. As part of NMFS' role in coordinating the Northwest 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 for killer whales. We developed an initial stranding protocol for killer whales for the network, and Raverty and Gaydos developed a detailed Killer Whale Necropsy and Disease Testing Protocol (www.vetmed.ucdavis.edu/whc/pdfs/orcanecropsyprotocol.pdf). In partnership with UC Davis, NMFS has provided funding to ensure prompt and thorough examinations are conducted on any stranded killer whale carcass. Gaydos and Raverty (2010) have compiled available information on stranded killer whales and causes of death, when known, since the Southern Residents were listed.

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 EA 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.

Each of these efforts to implement actions in the recovery plan is discussed below with respect to specific threats criteria.

Recovery Criteria
In the next section, we present the delisting and downlisting criteria from the Recovery Plan (NMFS 2008a). The criteria address both biological requirements and threats. The threats criteria are organized by the five listing factors. As presented in Table 1, there are some threats that fall under multiple listing factors. Following each set of criteria, we answer the question: have the criteria been met?

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 there has been an average 0.4 percent increase per year for the population. In 1982 there were 78 whales and in 2010 86 whales were counted in the summer census (86 whales by the end of 2010).

There is representation in all three pods, J (26 whales), K (19 whales), and L (41 whales). There are currently 3 reproductive males in J, 3 in K, and 10 in L pod. The current population is 38.3 percent juveniles, 32.5 percent reproductive females, 10.5 percent post-reproductive females, and 18.6 percent adult males. Olesiuk et al. (2005) reported that the Northern Residents have 47 percent juveniles, 24 percent reproductive females, 11 percent post-reproductive females, and 18 percent adult males. The age and sex class distribution is similar for both populations; however, the Southern Residents have a smaller percentage of juveniles and a higher percentage of reproductive females as compared to Northern Residents. 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).

The NWFSC and Alaska Fisheries Science Center continue to evaluate mortality rates and reproduction, and work on Population Viability Analyses similar to those conducted for the 2004 Status Review for Southern Resident Killer Whales (Krahn et al. 2004). Ward et al. (2009) reported that the estimated number of expected births (fecundity) of the Southern Residents increased slightly in recent years because of shifting age structure and recruitment of more young females; however, fecundity was slightly lower for Southern Residents compared to the Northern Residents.

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 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 some progress in assessing the habitat needs of the whales, we are just beginning to gather information 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 correlation studies revealing relationships between overall Chinook salmon abundance indices and Southern Resident killer whale survival and fecundity (Ford et al. 2010; Ward 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. The Center for Whale Research conducted a pilot study to evaluate body condition using aerial photogrammetry (Durban et al. 2009). Researchers took photographs of the Southern Residents from a helicopter and made measurements of different body sections of the whales (i.e., length, width). During the study, they observed one whale in poor condition that subsequently disappeared. While the pilot study was successful, particularly in estimating the length of each individual, additional photos and measurements are needed to evaluate if this is an effective method to track body condition of whales in different seasons and between years.

Durban et al. (2009) also summarized previous observations of whales in poor condition. Although whales have been observed as "skinny" with ribs showing or in poor condition (i.e., sunken neck known as "peanut head" condition), the whales that disappear are rarely recovered and therefore the cause of death cannot be determined. Stranding networks have recovered only a small number of stranded killer whales in recent years. Of the 18 reported killer whale strandings since 2005 (Gaydos and Raverty 2010), only one was identified as a Southern Resident and the cause of death was trauma from a vessel strike. Researchers conducting the necropsies did not attribute any of the deaths to starvation for any killer whales. The cause of death for about half of the stranded whales, however, was unknown.

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 test for disturbance (which could be related to commercial whale watching), and/or nutritional deficits (which could be related to the decline in Chinook salmon).

Reduced feeding behavior has been reported when vessels are present (Lusseau et al. 2009); 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.

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. Hanson et al. (2010) published a summary 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. This study included a larger sample size and geographic area than earlier studies and 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). This study 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 Pacific Salmon Treaty fisheries (NMFS 2008b), Pacific Fisheries Management Council coastal salmon fisheries (NMFS 2008c), and the Fraser Panel salmon fisheries in Puget Sound (2008d; 2009). 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 the continued existence of listed Chinook salmon.

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.

NMFS is currently evaluating the effects of the Puget Sound Fishery Management Plan for fisheries in Puget Sound including the Fraser Panel fisheries. Since our last fishery

consultation, we have new information to incorporate into our analysis. We have updated information on the population status, additional years of harvest data, and several new published papers on the metabolic needs of the whales (Noren 2011), prey preference (Hanson et al. 2010), and correlations between Chinook salmon abundance and fecundity (Ward et al. 2009).

A. Models used for salmon harvest management, such as the Fishery Regulation Assessment Model (FRAM) model (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 Pacific Salmon Treaty fisheries described above for killer whales also includes an analysis of effects on listed salmon (NMFS 2008b). 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.nwr.noaa.gov/Salmon-Harvest-Hatcheries/Salmon-Fishery-Management/Salmon-Harvest-BOs.cfm.

A3. Previous studies described in the Recovery Plan document decreasing trends for bioaccumulated contaminants in Puget Sound harbor seals (Calambokidis et al. 1999) 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). 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.

A4. NMFS has taken several management actions to reduce vessel disturbance. 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. For example, in 2010 NMFS supported additional efforts to promote responsible whale watching specific to kayakers (Koski 2010).

NMFS has coordinated with the U.S. Coast Guard, WDFW, and DFO to evaluate the need for regulations or areas with vessel restrictions. These are actions described in the Recovery Plan. Current voluntary guidelines are in place to encourage responsible vessel activity around the whales, but a vessel monitoring program has documented persistent violations of these guidelines for many years (Koski 2010). In March 2007, we published an Advance Notice of Proposed Rulemaking (72 Fed. Reg. 13464) to gather public input on whether and what type of regulation might be necessary to reduce vessel effects on Southern Residents. Based on public comments on the ANPR and new scientific information, NMFS determined

regulations were warranted. In July 2009, we published a draft EA under NEPA and proposed regulations (74 Fed. Reg. 37674). The proposed rule included three elements: 1) a prohibition on approaching killer whales within 200 yards, 2) a no-go zone prohibiting vessels from entering a 6 square mile area along the west side of San Juan Island from May 1-September 30, and 3) a prohibition on parking in the path of the whales. NMFS held three well-attended public meetings and received a large number of comments on the proposed rule. In a notice extending the comment period on the proposed rule, NMFS announced plans to work toward final regulations in time for the 2011 boating season. We are currently considering the comments and new information to develop the final rule. For final regulations, NMFS will develop an implementation plan that addresses the education and enforcement needs and identifies monitoring to assess the effectiveness of the regulations.

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' proposed regulations are intended to reduce the number of potentially harmful incidents when vessels are not following the responsible viewing guidelines. The draft EA and proposed rule include detailed information on what benefits NMFS expects for several alternatives, including the proposed regulations. NMFS will continue to work with the Soundwatch Boater Education Program 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.

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). 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.

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. In a review of 18 killer whale strandings since 2005, disease was not identified as a cause of death for the one Southern Resident (Gaydos and Raverty 2010). Two killer whales (one offshore and one transient) were diagnosed with bacterial infections and about half of all causes of death were unknown. Additional monitoring of the population and thorough examinations of any stranded killer whales are needed to ensure that diseases are not affecting the Southern Residents.

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 has worked with The Puget Sound Partnership, a community effort of citizens, governments, tribes, scientists, and businesses working together to restore and protect Puget Sound. NMFS participated in efforts of the Puget Sound Partnership to develop a strategy for cleaning up, restoring, and protecting Puget Sound by 2020. In 2009, the Partnership released an 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 2009). 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 B.

E4. Research projects are underway to increase 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, are using 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. The NWFSC has also conducted dedicated ocean class shipboard visual and acoustic surveys to locate and track killer whales. On three of the past four cruises, NWFSC scientists have located the Southern Residents along the Washington and Oregon coasts. While these methods have increased the number of sightings of whales in recent years, additional information on coastal distribution and habitat use is needed to assess threats from coastal activities (i.e., fisheries, alternative energy projects) and to identify the constituent elements

of critical habitat in the Pacific Ocean. The NWFSC has developed a proposal to satellite tag a small number of Southern Residents and this proposal was published for public review as part of the permitting process (75 Fed. Reg. 68757, November 9, 2010). Tracks of Southern Resident killer whales along the coast will greatly increase our knowledge of their movements in coastal waters and inform management and recovery.

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. Over the last 14 years there has been an average 0.8 percent decrease per year for the population. In 1996, there were 97 whales and in 2010 there were 86 whales counted in the summer census (86 whales by the end of 2010).

There is representation in all three pods, J (27 whales), K (19 whales), and L (42 whales). There are currently 3 reproductive males in J, 3 in K, and 10 in L pod. The current population is 38.3 percent juveniles, 32.5 percent reproductive females, 10.5 percent post-reproductive females, and 18.6 percent adult males.

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 Northwest Region and in the Southwest Region. In the Northwest Region, NMFS has delineated four recovery domains, or geographic recovery planning areas, for the salmon and steelhead populations listed under the ESA. The four domains with recovery-planning activities are Puget Sound; Willamette/Lower Columbia; Oregon Coast; and Interior Columbia, which has three sub-domains of Middle Columbia, Snake, and Upper Columbia.

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, Hood Canal Summer Chum salmon, Lake Ozette Sockeye salmon, and the Middle and Upper Columbia Sub-Domains; other plans are in development. For additional information on the status of salmon recovery plans, please visit http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Draft-Plans.cfm.

A2. Several research projects are underway to increase knowledge of the foraging ecology of Southern Residents. Hanson et al. (2010) published a summary 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. This study included a larger sample size and geographic area than earlier studies and 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). 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). 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.

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 B 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, studies cited in the Recovery Plan document decreasing trends for bioaccumulated contaminants in Puget Sound harbor seals (Calambokidis et al. 1999) 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). 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 B 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. 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. For example, in 2010 NMFS supported additional efforts to promote responsible whale watching specific to kayakers (Koski 2010).

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 (Caretta et al. 2010). 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.

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 ensure that diseases are not affecting the Southern Residents.

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. 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 B.

E3. NMFS is part of an active research program. Appendix B identifies NMFS support for research actions in the Recovery Plan, many of which are designed to assess the threats to the

whales. In 2009, the NWFSC compiled recent research results and developed a Newsletter to provide new information to the public and stakeholder groups, such as the whale watch industry and their naturalists (Appendix A). Section 2.3 of this review includes a list of several recent publications listed in the Newsletter, and others that have come out since the Recovery Plan was completed.

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.

2.3 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 and is used in Section 2.2 of this 5-year review. Since section 2.2.3 provides sufficient information to evaluate the species listing classification, this section briefly cites but does not summarize current information on species status. The latest NMFS stock assessment for the Southern Residents contains updated information and the reference is provided in the list below (Caretta et al. 2010). There is an active research program and the NWFSC listed several new publications in their 2009 Newsletter (Appendix A) which are also listed below. Researchers have completed new papers since we completed the Recovery Plan and Newsletter. Additional papers related to the major threats published since the Newsletter are provided below. The draft EA for the proposed vessel regulations includes a review of the latest information on vessel impacts and several new papers referenced in the EA are included in the list below. Recent biological opinions also incorporate the latest information from scientific papers and unpublished data. During the public comment period, NMFS received copies of several new reports on killer whales and a recent thesis, and these are also included in the list of new references. 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.

Population Status

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.

Prey

Au, W. W. L., J. Horne, and C. Jones. (2010). Basis of acoustic discrimination of Chinook salmon from other salmons by echolocating *Orcinus orca*. Journal of the Acoustical Society of America Volume 128(4), pages 2225 to 2232.

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.

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.

Noren, D. P. 2011. Estimated field metabolic rates and prey requirements of resident killer whales. Marine Mammal Science. Marine Mammal Science Volume 27(1), pages 60 to 77.

NMFS. 2008. 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.

Ward, E. J., E. E. Holmes, and K. C. Balcomb. 2009. Quantifying the effects of prey abundance on killer whale reproduction. Journal of Applied Ecology. Volume 46(3), pages 632 to 640.

Vessels and Sound

Holt, M. M. 2008. Sound exposure and Southern Resident killer whales (*Orcinus orca*): A review of current knowledge and data gaps. U.S. Department of Commerce, Seattle, Washington. NMFS -NWFSC-89. 59 pages.

Holt, M. M., Noren, D. P., Veirs, V., Emmons, C., and Veirs, S. 2009. Speaking up: Killer whales (*Orcinus orca*) increase their call amplitude in response to vessel noise. Journal of the Acoustical Society of America Express Letters. Volume 125, pages EL27 to EL32.

Koski, K. 2010. 2010 Final program report: Soundwatch Public Outreach/Boater Education Project. The Whale Museum, Friday Harbor, Washington.

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.

Noren, D. P., A. H. Johnson, D. Rehder, A. Larson. 2009. Close approaches by vessels elicit surface active behaviors by Southern Resident killer whales. Endangered Species Research, 8(3):179-192.

Williams, R., Bain, D. E., Smith, J. C., and Lusseau, D. 2009. Effects of vessels on behaviour patterns of individual southern resident killer whales *Orcinus orca*. Endangered Species Research. Volume 6, pages 199 to 209.

Contaminants

Krahn, M. M., M. B. Hanson, G. S. Schorr, C. K. Emmons, D. G. Burrows, J. L. Bolton, R. W. Baird, G. M. Ylitalo. 2009. Effects of age, sex and reproductive status on persistent organic

pollutant concentrations in "Southern Resident" killer whales. Marine Pollution Bulletin, 58:1522-1529.

Mongillo, T. M. 2010. Estimated polychlorinated biphenyl (PCB) and polybrominated diphenyl ether (PBDE) accumulation in Southern Resident killer whales. Master's Thesis, University of Washington. 107 p.

Puget Sound Partnership. 2009. Puget Sound Action Agenda, Protecting and Restoring the Puget Sound Ecosystem by 2020. Olympia, Washington. 204 pages. www.psp.wa.gov

Strandings

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.

Oil spills

Matkin, C. O., E. L. Saulitis, G. M. Ellis, P. Olesiuk, and S. D. Rice. Ongoing population-level impacts on killer whales *Orcinus orca* following the 'Exxon Valdez' oil spill in Prince William Sound, Alaska. Marine Ecology Progress. Volume 356, pages 269 to 281.

Spacial distribution, movements and habitat use

Ashe, E., D. P. Noren, R. Williams. 2010. Animal Behaviour and Protected Areas: Habitat Conservation for an Endangered Killer Whale Population. Animal Conservation. Volume 13(2), pages 196 to 203.

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.

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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.

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Ward, E. J., B. X. Semmens, E. E. Holmes, and K. C. Balcomb. 2011. Identifying links between population groupings and demography in at-risk species with multiple levels of social structure. Conservation Biology, in press.

Ward, E. J., E. E. Holmes, K. Parsons, K. C. Balcomb, and J. K. B. Ford. 2009. The role of menopause and reproductive senescence in a long-lived social mammal. Frontiers in Zoology. Volume 6(4). doi:10.1186/1742-9994-6-4.

Transient killer whales

Mock, K. J., and J. W. Testa. 2007. An agent-based model of predator-prey relationships between transient killer whales and other marine mammals. Final Report for Marine Mammal Commission Grant #EE0009709.

Wade, P. R. 2005. Population biology of killer whales and their marine mammal prey in the North Pacific. Prepared for the Workshop on the Ecological Role of Killer Whales in the North Pacific Ocean, Marine Mammal Commission, April 19-21, 2005, Seattle, Washington.

2.4 Synthesis

Southern Resident killer whales were listed as endangered in 2005. In the five 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, 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: salmon recovery, oil spill response, and reducing vessel impacts (Table 1). 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 proposed 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 end of 2010, there were 86 whales. 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 (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.

3.0 RESULTS

3.1 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*
__X**__ No change is needed**

3.2 New Recovery Priority Number: No change

4.0 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. 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.

In the next five years, particular priority should be focused on the following management and research actions:

- Finalizing and implementing regulations to protect killer whales from vessel impacts, including assessing effectiveness of regulations in reducing vessel impacts;
- Continuing preparations for a major oil spill, including developing response protocols, training personnel, and securing equipment;
- Synthesizing existing information, filling data gaps, and evaluating potential effects of salmon harvest and hatchery actions on the prey base of killer whales;
- Conducting research on the health status of individual whales, including assessing health in different seasons to determine when and where prey limitation may affect reproduction and survival, full examinations of stranded animals, and links between contaminant levels and health; and
- Increasing knowledge of coastal distribution, habitat use, and prey consumption to inform critical habitat determination, identify any unknown threats, and assess and minimize impacts of ongoing and new coastal activities (i.e., fisheries, alternative energy projects).

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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
_X_ No change needed

Review Conducted By: National Marine Fisheries Service
Northwest Regional Office

REGIONAL OFFICE APPROVAL:

Lead Regional Administrator, National Marine Fisheries Service

Approve _____ Date 2/15/2011

The Lead Region must ensure that other regions within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. Written concurrence from other regions is required.

HEADQUARTERS APPROVAL:

Assistant Administrator, NOAA Fisheries

✓ Concur ____ Do Not Concur

Signature _____ Date MAR 15 2011

Appendix A

NWFSC 2009 Newsletter

Northwest Fisheries Science Center

Southern Resident Killer Whales

January 2009

Inside This Issue

Update on Recent Research Results

Background

The Southern Resident killer whales (SRKWs) that reside in the Puget Sound region experienced a dramatic decline in the mid-1990s, and as a consequence were listed as Endangered under the Endangered Species Act (ESA) in 2005. Prior to this ESA listing, Congress initiated funding in 2003 for NOAA's Northwest Fisheries Science Center (NWFSC) to support research to address key questions that must be answered to successfully conserve these whales. Here we briefly summarize some of our latest research results on their taxonomy, behavior, ecology, health, anthropogenic impacts and socioeconomic importance to the citizens of the Pacific Northwest.

Taxonomy and Genetic Relationships

Currently, there is only one recognized global species of killer whales. However, recent data suggest that there are likely several subspecies and potentially more than one species of killer whale worldwide. Furthermore, little is known about the historical range of killer whale ecotypes in the eastern North Pacific (ENP). It is possible that ranges have shifted in the last few decades because of changes in availability of food. To conserve and manage killer whales, we need to identify the number and distribution of distinct populations of killer whale species. Several projects have been funded to determine genetic relationships between Southern Resident killer whales and other killer whales. Results have helped scientists determine how genetically distinct different groups of killer whales are, whether the different groups are interbreeding, and the historical distribution of the SRKW population. For example, Dr. Phil Morin (NOAA NMFS Southwest Fisheries Science Center) examined killer whale genetics from archeological samples of teeth and bones to investigate historical distributions of SRKWs and the other ENP ecotypes. Results did not show any Southern Resident haplotypes in samples from south of Washington State inland waterways. One whale genetically identified as a Northern Resident extends the known southernmost distribution of the population from Oregon to California.

Peer-reviewed publication: Morin, P.A., LeDuc, R.G., Robertson, K.M., Hedrick, N.M., Perrin, W.F., Etnier, M., Wade, P., and Taylor, B.L. 2006. Genetic Analysis of killer whale (Orcinus orca) historical bone and tooth samples to identify western U.S. ecotypes. Marine Mammal Science 22(4): 897–909.

Using only contemporary tissue samples, Dr. Rus Hoelzel (University of Durham) and colleagues estimated average rates of gene flow (genetically effective migration) between the SRKW population and other sampled killer whale populations (offshore, transient, and resident ecotypes) from several geographic regions. These researchers found that the genetic structure was similar between population ecotypes and also found evidence for genetic isolation with geographic distance within ecotypes. Using a model, they predicted that there is ongoing, low-level migration between regional populations (within and between ecotypes) and small effective sizes for extant local populations. Their results indicate a key role for social and foraging behavior in the evolution of genetic structure among conspecific populations of the killer whale.

Peer-reviewed publication: Hoelzel, A.R., Hey, J., Dahlheim, M.E., Nicholson, C., Burkanov, V. and Black, N. 2007. Evolution of population structure in a highly social top predator, the killer whale. Molecular Biology and Evolution 24: 1407-1415.

Population Monitoring and Social Structure

The annual census of the Southern Resident killer whale population is an important method by which to assess the status and trends of this endangered population. Photo-identification studies can also provide insight into population dynamics and demography, social structure, and individual life histories. Quantitatively characterizing the social structure of a population provides important insight into the forces shaping key population processes. Moreover, long-term social dynamics provide an avenue for understanding population level responses to changes in socioecological conditions.

"Orca Survey" was launched as a census to determine the status of the Southern Resident killer whales. This project is a long-term photo-identification study of killer whales (*Orcinus orca*) in the San Juan Island area of the Pacific Northwest. Principal Investigator Ken Balcomb (Center for Whale Research) initiated the study in 1976 (under contract to the National Marine Fisheries Service) to ascertain the size of the population of killer whales in the Greater Puget Sound area of Washington State. For over three decades, the Center for Whale Research (CWR) has been conducting annual photo-identification studies of the SRKW population that frequents the inland waters of Washington State and lower British Columbia. This detailed understanding of population status and trends has supported management decisions in both Canada and the United States, including the listing of SRKWs as Endangered in both countries. The data collected during annual surveys provide recent photographs to update photo-identification guides; provide managers with current information on SRKW population status and trends; and provide information on population dynamics, social structure, and individual life histories that can be used for further scientific analysis. The census data are updated annually in catalogs produced by and available from the Center for Whale Research. Up-to-date information is also available at http://www.whaleresearch.com

One study that used the long-term census data from CWR was conducted by Dr. Kim Parsons (NRC post-doctoral associate, NOAA NMFS NWFSC and the Center for Whale Research). She, along with her collaborators, quantitatively assessed social structure in the SRKW population from 29 years of photo-identification data and characterized significant temporal changes in sociality. They found that preferential affiliation among killer whales within both genealogical matrilines and pods was supported by two different analytical methods and, despite interannual variability, these social clusters persisted throughout the study. All three pods experienced fluctuations in social cohesion over time, but the overall rate of intrapod affiliation was consistently lowest within L pod, the largest of the Southern Resident pods. The most recent increase in fluidity within social units, occurring in the mid to late-1990s, was coincident with a significant decline in population size, suggesting a possible common response to external stressors. Quantifying these trends in social structure is the first step towards understanding the causes and consequences of long-term changes in killer whale social structure.

Peer-reviewed publication: Parsons, K.M., Balcomb, K.C., Ford, J.K.B., and Durban, J.W. In press. The social dynamics of southern resident killer whales and conservation implications for this endangered population. Animal Behaviour.

Southern Resident Killer Whales - Update on Recent Research Results

Seasonal Distribution

A series of workshops that assessed research needs for Southern Resident killer whales identified the population's winter distribution as a primary data gap. In order to determine winter distribution, it is important to fully document sighting and detection locations in inland as well as in coastal waters. The NWFSC has used a mixture of technologies, including passive acoustic monitoring, a land-based sighting network, and coastal research cruises to greatly expand our efforts to fill these data gaps.

The NWFSC supports Orca Network as a central reporting point for all killer whales sighting and acoustic detections on the SeaSound Remote Sensing Network. This hydrophone network (http://www.whalemuseum.org/seasound/ref.html) is a partnership of NOAA NMFS, The Whale Museum, OrcaSound, Beam Reach, and many others. The principal investigators of this project are Dr. Jason Wood (The Whale Museum, Beam Reach), Dr. Val Veirs (The Whale Museum, OrcaSound and Beam Reach), and Dr. Scott Veirs (Beam Reach). Currently, there are five hydrophones deployed throughout the Salish Sea Region. These include two on the west side of San Juan Island (Lime Kiln Lighthouse and Smugglers Cove), one at the Port Townsend Marine Science Center, one at the Seattle Aquarium, and one at Neah Bay (near the Makah Cultural Center). These hydrophones allow real-time access for researchers and the general public to monitor acoustic signals from killer whales at these locations. These hydrophones are in operation year-round and are providing information on movement patterns of Southern Resident killer whales, as well as time series of calibrated average sound pressure levels. The Salish Sea hydrophone network website (http://orcasound.net) allows the public to listen to live streams from the hydrophones and access archived sounds. The website also includes links to hydrophones, field cameras, and environmental sensors operated by other groups.

The NWFSC has used several approaches to collect SRKW location information on the Pacific coast. For example, a coastal sighting network was developed and maintained by the Center for Whale Research (principal investigator, Ken Balcomb). The CWR distributes posters and cards that contain sighting network contact information so that the general public can report all sightings of killer whales along the west coast of the US, from Washington to central California. A second approach has been to deploy moorings with passive acoustic recorders at key locations along the US West Coast. The principal investigators of this project are: Dr. Brad Hanson (NOAA NWFSC), Dr. Jeff Nystuen (University of Washington), and Dr. Marc Lammers (Oceanwide Sciences Institute). Unlike the Salish Sea hydrophone network, the PALs (Passive Acoustic Listening devices) and EARs (Ecological Acoustic Recorders), record acoustic signals over a set time period and then must be recovered to retrieve the acoustic information. These devices have been very successful in detecting and recording Southern Resident killer whales (and other marine mammals) in off-shore locations that are very difficult for researchers to access during the winter season when weather and sea-state conditions are often poor. The information gained from these devices provides additional information on the timing and duration of the whale's movements through these areas. A third approach has been to conduct dedicated ocean class shipboard visual and acoustic surveys to locate and track SRKWs. These cruises have been very successful. SRKWs have been located along the Washington and Oregon coasts on 3 of the past 4 cruises conducted by NWFSC scientists.

Habitat Use

Defining Critical Habitat is a requirement of an ESA species listing. The sighting locations in the summer range provided a rich dataset to allow this task to be completed for the inland waters of Washington. Understanding habitat use in the summer core region near the San Juan Islands and Canadian Gulf Islands is important for future conservation actions. Several methods have been and are currently being used to better understand pod-specific distribution patterns, movement patterns, and the behavior of Southern Resident killer whales when they are in inland waters, particularly during the summer, but also year-round.

The first step in understanding habitat use and movement patterns of SRKWs was to compile a database of all available SRKW sightings. To accomplish this task, the Whale Museum has archived all inland water killer whale visual sightings/acoustic detections for the past 30 years. The database is composed of all available sighting data from the inland marine waters of Washington State and Southern British Columbia on the Southern Resident population. The primary data sources for this database are: 1) The Whale Museum's sighting archives (which includes all Orca Network sightings posted on the internet, as well as the Museum's Whale Hotline, and sightings from Museum affiliated researchers, naturalists, and whale-watch companies); 2) Commercial whale-watch pager reports; 3) Soundwatch Boater Education program data; 4) a longitudinal data set from Lime Kiln Point State Park; and 5) all acoustic detections. This database is updated annually and has been made freely available to managers and researchers as a common baseline from which to evaluate the movements of the SRKWs in the inland waters of Washington State and British Columbia.

This database was also used by Donna Hauser (University of Washington) for her master's thesis which aimed to determine the distribution patterns of the three pods of Southern Resident killer whales in their designated summer core critical habitat. Specifically, she used 6 years of sighting information (from whalewatch pager reports) within the inshore waters of Washington and British Columbia, to model pod-specific summer distribution and measure relative variation in the density of sightings on a uniform spatial grid. The results indicate that the pods exhibit complex, non-uniform summer space-use patterns. Although some regions are used in common by all pods, some areas are used almost exclusively by individual pods or certain combinations of pods, indicating specialization to particular areas. For example, all pods commonly used Haro Strait (west side of San Juan Island) while L pod alone appeared to frequent the area in the Strait of Juan de Fuca south of Vancouver Island.

Peer-reviewed publications: Hauser, D.D.W., Logsdon, M.G., Holmes, E.E., VanBlaricom, G.R., and Osborne, R.W. 2007. Summer distribution patterns of Southern Resident killer whales (*Orcinus orca*): evidence of core areas and spatial segregation of social groups. Marine Ecology Progress Series 351: 301-310.

Hauser, D.D.W., VanBlaricom, G.R., Holmes, E.E., and Osborne, R.W. 2006. Evaluating the use of whalewatch data in determining killer whale (*Orcinus orca*) distribution patterns. Journal of Cetacean Research & Management 8:273-281.

Building on Donna Hauser's work, Dr. Dawn Noren (NOAA NMFS NWFSC) worked with Ms. Hauser to geographically analyze data that were collected in 2006 for Dr. Noren's study on vessel impacts to better understand Southern Resident killer whale habitat use patterns in their core summer critical habitat. Specifically, they used killer whale group activity state data and individual killer whale data on swimming speeds, dive durations, etc to determine habitat use patterns in a uniform spatial grid of one km^2 cells. Differences in diving and swimming patterns as well as directionality and spatial arrangements among the four behaviors (rest, social, travel, forage) suggest that the four behaviors likely serve distinct functions for Southern Resident killer whales. Furthermore, foraging and resting behaviors tended to occur in more localized regions within the core summer habitat. In particular, travel was the predominant behavior that occurred along the west side of San Juan Island while foraging occurred predominantly along the southwest portion of San Juan Island. Resting occurred southwest of Lopez Island as well as south and west of Henry Island. These results have implications for potential future management actions, particularly for the selection of reserve areas where killer whales are protected from vessel traffic and other human activities.

Southern Resident Killer Whales - Update on Recent Research Results

Foraging Behavior and Prey Relationships

Prey abundance has been suggested to be a significant factor affecting Southern Resident killer whales. Thus, it is important to determine what fish the whales are consuming as well as assess how the killer whale population and its movement patterns are influenced by their prey.

Previous research suggested that the whales showed a strong preference for Chinook salmon, but these studies were limited by a small sample size. Over the past four years, Dr. Brad Hanson (NOAA NMFS NWFSC) and Dr. Robin Baird (Cascadia Research Collective) have followed whales in the San Islands to collect prey remains following feeding events. Their efforts have expanded the sample size of prey to approximately 150 prey items analyzed. As part of a collaborative effort with Dr. John Ford, they have combined these samples with those collected by Dr. Ford's colleagues in the western Strait of Juan de Fuca. The results of this study confirm the importance of Chinook salmon in the diet of Southern Resident killer whales. Additional analyses using newly developed genetic tools have allowed them to determine that the Fraser River Chinook, and in particular fish from the Upper Middle, and Lower Fraser, and South Thompson are of particular importance to the whales. Using a complementary approach to address the question of prey selection, these researchers and their collaborators initiated another project to genetically analyze prey remains in SRKW feces. The results from this approach also indicate that Chinook salmon is of major importance, although a few other salmon species (no sockeye or pink) as well as some halibut, Dover sole, and lingcod were also found to be part of their diet. The data collected in this study also include behavioral characterization of predation events of Southern Resident killer whales in time and space. In collaboration with Evergreen State College student Jeremy Lucas, Drs. Hanson and Baird have identified preferred feeding sites of SRKWs in their summer range as well as the unique characteristics associated with these sites.

In another study that investigated SRKW foraging behavior, Drs. Robin Baird and Brad Hanson used suction cup-attached time-depth recorders to test the hypotheses that dive rates (number of dives per hour greater than or equal to specific depths) varied between males and females, with age, between day and night, and among pods and years. Dive rates to deeper depths during the day decreased over the study, suggesting a long-term change in prey behavior or abundance, though uncertainty regarding the diet of this population precludes determination of the cause of such changes.

Peer-reviewed publication: Baird, R.W., Hanson, M.B., and Dill, L.M. 2005. Factors influencing the diving behaviour of fish-eating killer whales: sex differences and diel and interannual variation in diving rates. Canadian Journal of Zoology: 257-267.

For her master's thesis, Shannon McCluskey (University of Washington) made a pioneering effort to link the spatially explicit movement behavior of the Southern Resident killer whale population to spatially distributed estimates of salmon abundance. She also assessed how killer whale movement patterns changed prior to and during the population decline as well as how the killer whale population varied with salmon abundance. Generally, whales were not found to distribute themselves preferentially in areas of highest weekly salmon catch, however these insignificant findings may reflect differences in temporal or species scale more than true randomness of distribution on the part of the whales. Interestingly, movement patterns of all three killer whale pods were significantly different during the early 1990s when the population was increasing and the latter 1990s when the population was decreasing. Finally, the population of Southern Resident killer whales tended to fluctuate in response to population fluctuations of salmon.

Scientists attempt to collect prey and/or fecal samples from J pod in the Puget Sound.

Physiology, Energetics, Stress, Disease, and Environmental Impacts

Some of the risk factors associated with the decline of the SRKWs include nutritional stress due to low prey abundance and/or quality, exposure to toxins (particularly PCBs and PBDEs), and disturbance from boat traffic. Physiological studies and programs that collect samples from free-ranging killer whales can be used to assess the importance of each of the risk factors as well as provide data to determine the health status of the SRKW population. The NWFSC has supported several studies that collect samples to assess the health of SRKWs as well as provide information on the bioenergetics (energetic cost of daily activities and food consumption requirements) of SRKWs.

In 2006, Dr. Brad Hanson (NOAA NMFS NWFSC) and Dr. Robin Baird (Cascadia Research Collective) initiated a biopsy sampling program to safely obtain small blubber samples from key individual whales. The analysis of the initial six samples by Dr. Peggy Krahn and others from the Environmental Assessment Program at the NWFSC confirmed that Polychlorinated Biphenyls (PCBs) burdens are high, although somewhat lower than they were when the last samples were analyzed over a decade ago. Levels of new generation contaminants, such as polybrominated diphenyl ethers (PBDEs, or flame retardants), increased, however, and were particularly high in the one juvenile animal that was sampled. Samples from J and L pods had markedly different contaminant profiles, indicating that these two pods occupy different ranges in winter. However, their carbon and nitrogen stable isotope signatures do indicate that J and L pods consumed prey from similar trophic levels. This information will be important for determining where to target clean up efforts. The NWFSC is continuing to collect biopsy samples from all three pods to further assess this factor.

Peer-reviewed publication: Krahn, M.M., Hanson, M.B., Baird, R.W., Boyer, R.H., Burrows, D.G., Emmons, C.K., Ford, J.K., Jones, L.L, Noren, D.P., Ross, P.S., Schorr, G.S., and Collier, T.K. 2007. Persistent organic pollutants and stable isotopes in biopsy samples (2004/2006) from Southern Resident killer whales. Marine Pollution Bulletin 54:1903-1911.

For her Ph.D. dissertation, Katherine Ayres (University of Washington), along with her advisor, Dr. Sam Wasser (University of Washington.), and other collaborators collect fecal matter to investigate the relative effects of disturbance from private and commercial whale watching vessels and decline in Chinook salmon. Specifically these researchers are using noninvasive hormone measures of stress (glucocorticoids, or GCs) and nutrition (triiodothyronine, or T3) in feces to test for disturbance, which could be related to commercial whale watching, and/or nutritional deficits, which could be related to the decline in Chinook salmon (reduced prey hypothesis). Thus far, the hormone data support the reduced prey hypothesis. Seasonal trends in both GCs and T3 are consistent with winter being a time of low food intake compared to summer. Also, average T3 levels are lower in years when SRKW mortality is higher, consistent with the reduced prey hypothesis and suggesting a link between low food intake and mortality. While the results are most consistent with the reduced prey hypothesis on long time scales (i.e. months and years), preliminary results also suggest that stress hormones in killer whales may be linked to vessel numbers on short time scales (i.e., days) and perhaps these pressures interact.

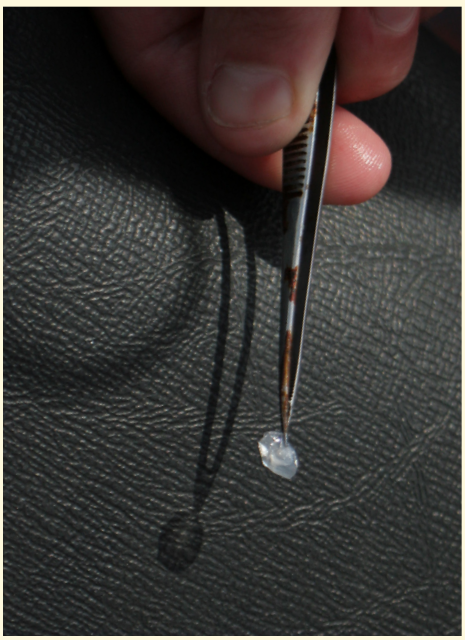
Fecal samples collected from Southern Resident killer whales will be used for diet and genetics analysis.

In order to assess if the salmon populations are sufficient to support the population of Southern Resident killer whales, it is important to determine how many fish are available and equally important to know how many fish each whale needs to consume per day to survive. To assess the energetic requirements of killer whales, it is first necessary to understand how much energy killer whales expend per day. As a first step in determining energetic requirements of killer whales, Dr. Rob Williams (University of British Columbia) and Dr. Dawn Noren (NOAA NMFS NWFSC) used respiration rate and swimming speed data from Northern Resident killer whales in combination with published respirometry values to determine the cost of swimming at various speeds for adult killer whales. They found that energy expenditure increases with increasing swimming speeds, but that the most efficient (lowest energetic expenditure per distance travelled) swim speed for whales travelling long distances is approximately 2.6 – 3.0 m/s.

Peer-reviewed publication: Williams, R. and Noren, D.P. In press. Swimming speed, respiration rate and estimated cost of transport in adult killer whales. Marine Mammal Science.

Southern Resident Killer Whales - Update on Recent Research Results

Another study conducted by Dr. Dawn Noren used daily activity budgets to estimate the total energy expenditure and prey energy requirements of all individuals in the Southern Resident killer whale population. The results show that energy expenditure and prey consumption increases with age and body size. Not surprisingly, individual adult male killer whales require more food per day than adult females. However, since the Southern Resident killer whale population is comprised of many more adult females than adult males, this segment of the population, as a whole, consumes the majority of the total prey consumed by Southern Resident killer whales. Furthermore the number of fish consumed per killer whale varies with the size and species of the fish. For example, if Southern Resident killer whales only consume Chinook, which are large and energy-rich, they will consume fewer fish than if they only consumed chum, which are smaller and less energy-rich. These results provide one explanation of why Southern Resident killer whales seem to prefer Chinook over other salmon species.



Scales collected after a prey event by a Southern Resident killer whales can be used to identify the species, age, and stock of the fish it came from.

Vessel Interactions and Ambient Noise

Boat traffic has increased considerably in the whales' summer core range and may have detrimental effects on the whales' foraging success and ultimately survival. In collaboration with university and non-governmental organization partners, the NWFSC has conducted and funded several studies to examine the trends in vessel interactions and how the whales react to vessels.

Soundwatch (operated by the Whale Museum) provides on-the-water stewardship, public outreach, and boater education, as well as collects data on the number of vessels in the vicinity of killer whales and compliance with whale watch guidelines. Prior to 1976, whale watching in this region was virtually non-existent. This industry exhibited a nearly continuous annual growth from 1984 through 1998. Since 2001, however, the number of U.S. and Canadian whale watch companies has remained relatively level. For example, from 2003-2006, the number of Canadian companies have ranged from 19-22 while the number of U.S. companies have ranged from 17-19. There has also been a shift in the industry towards more Canadian vessels. From 2003-2006, the number of Canadian vessels has increased from 45 to 54 while the number of U.S. vessels has decreased from 28 to 22. In addition to commercial whale watch vessels, this region also attracts great numbers of commercial kayaking companies and private boaters (including kayakers) both for fishing and general recreation. In general, the whales have consistently had an average of approximately 20 vessels of various types within a half-mile of their location from 1998-2006. There is great daily and monthly variability in the numbers of boats with whales. Thus, average numbers of vessels with whales may not be the best way to truly assess vessel number trends. For example, in 2006 the highest vessel count near the whales was 69. In 2003, the most common vessel incidents included: 1) vessels parking in the path of whales, 2) vessels motoring inshore of whales, 3) vessels within the ¼ mile voluntary no go zone, and 4) vessels motoring within 100 yards of whales. In 2004, vessels motoring inshore of whales replaced vessels parking in the path of whales as the most commonly observed incident. Also, in 2004 and 2005 percentages of vessels motoring within 100 yards of whales and motoring faster than 5-7 knots within ¼ mile of the whales were equal, tying for 4th in vessel incidents. Similar to previous years, the most commonly observed vessel incidents in 2006 were 1) vessels parking in the path of whales, 2) vessels motoring inshore of whales, 3) vessels motoring within 100 yards of whales, and 4) vessels motoring fast within 400 yards of whales. Vessel incident by vessel type have remained nearly the same since 2003 and occur primarily by private operators (51%) followed by Canadian commercial operators (21%) and then US commercial operators (9%).

In another study, Drs. David Bain (University of Washington), Rob Williams (St. Andrews University), David Lusseau (University of Aberdeen), and Jodi Smith (Massey University at Albany) collected data to determine relationships between SRKW behavior and vessels. The researchers measured the behavior of Southern Resident killer whales in the presence and absence of vessels from 2003 to 2005 at 2 different sites along San Juan Island, Washington, USA. They used a theodolite to track individual killer whales to determine swimming path directness and deviation indices, travel speed, and rates of respiration and surface active display behaviors. They also observed activity states of killer whale groups using scan sampling and collected information on the number of vessels present at various distances from the whales. The major findings of this study were that killer whales reduced their time spent foraging when vessels were present,

which is similar to the response observed previously in Northern Resident killer whales. Furthermore, the relationships between number and proximity of vessels and whale behavior are complex. Yet, in general, killer whales swam in more erratic paths when many boats were present.

Peer-reviewed publications: 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 6:211-221.

Williams, R., Bain, D.E., Smith, J.C., and Lusseau, D. 2009. Effects of vessels on behaviour patterns of individual southern resident killer whales *Orcinus orca*. Endangered Species Research 6:199-209.

For her Ph.D. dissertation, Jennifer Marsh (University of Washington.) studied the behavior of Southern Resident killer whales and its relationship with several ecological factors, including vessel presence. Specifically, generalized behaviors (rest, play, forage, travel) and two measures of social behavior (percussive behavior and synchronous surfacings) were examined because it was hypothesized that each of these might vary with whale-watching pressure. Percussive behaviors (also called surface active behaviors) are considered by some to be communicative and may convey information to conspecifics. Synchronous surfacings may represent a social bond between two animals and has previously been used to define the strength of affiliation among conspecifics. The results showed that some behaviors were correlated with each other and also with ecological factors. For example, some behaviors (e.g., cartwheels and breaches) were more prevalent during the afternoon while other behaviors (e.g., physical contact and spyhop) increased with increasing number of vessels present. Meanwhile, behavior states (rest, play, forage, travel) did not appear to be related to the number of vessels present. The results of this study demonstrate that killer whale behavior is very complex, and that several varying ecological factors may affect killer whale behavior.

Scientists collect acoustic recordings and killer whale behavioral data in the San Juan Islands.

To assess potential energetic impacts of behavioral responses to vessel disturbance, Dr. Dawn Noren (NOAA NMFS NWFSC) and her collaborators collected data in the San Juan Islands, USA and Gulf Islands, Canada during the summers of 2004 - 2006. Continuous behavioral data, including dive durations, surface durations, swim speeds, and the performance of surface active behaviors (SABs; e.g., spy hops, breaches, tail slaps, pectoral fin slaps) were recorded from individual adult Southern Resident killer whales using a focal follow approach. Vessel counts and distances between the focal whale and the nearest vessels were measured every 10 minutes. In 2006, distances were measured every 5 minutes and during every performance of an SAB by the focal whale. Relationships between vessel presence and dive and surface durations and swimming speeds are very complex, and are still being analyzed. Analysis of the relationships between vessel distance and the occurrence of SABs suggest that close approaches by vessels may elicit a behavioral response. The highest frequency of SABs occurred when the nearest vessel was within 75-99 meters and 125-149 meters of the focal whale in 2005 and 2006, respectively. Furthermore, a significantly greater proportion of SABs occurred when vessels closely approached whales. Finally, there was a significant temporal relationship between close approaches and the occurrence of SABs. Specifically, the majority of SABs were performed immediately prior to or soon after the closest approach by a vessel. These results suggest that close approaches by vessels (including distances greater than 100 m) elicit behavioral responses in SRKWs.

Southern Resident Killer Whales - Update on Recent Research Results

Previous experimental studies documented stereotyped avoidance responses by killer whales to boats. Additional observations collected during these studies also showed an apparent shift in avoidance behavior at high traffic levels. A study conducted by Dr. Rob Williams (University of British Columbia) and collaborators experimentally tested whether Northern Resident killer whales responded differently to approach by few (1–3) versus many (>3) vessels. Data were collected during the summer of 2004 in Johnstone Strait, British Columbia, using a theodolite to track the positions of boats and individually identifiable focal whales during approaches of few versus many boats. Swimming paths became more tortuous when few boats approached whales, but straighter as many boats approached. Pooling treatments would have masked significant responses, falsely suggesting that boat presence had no effect. The division between few and many boats was also supported by 140 opportunistic observations of 26 whales from a population of 216.

Peer-reviewed publication: Williams, R. and Ashe, E. 2007. Killer whale evasive tactics vary with boat number. Journal of Zoology (London) 272: 390-397.

For her Ph.D. dissertation, Deborah Giles (University of California Davis, the Whale Museum) collected data during the summer and fall seasons of 2007 and 2008 to characterize spatial and temporal distributions of Southern Resident killer whales with an emphasis on group cohesion and activity state under varying conditions. This biogeography research will examine the relationship between whale behavior and variables such as bathymetry (underwater topography), currents, season, day of the week, and number of vessels. One component of the study will assess whether vessel density, their mode of vessel operation, and their distance to the whales affect the whales' group spatial structure and/or activity state. Ms. Giles will also determine whether these variables and responses vary geographically. Her data collection method is unlike any other that has been attempted from a boat-based platform. Specifically, she uses an integrated equipment package which includes a global positioning system (GPS) with built-in data collector to record attribute data (e.g. whale identification, group size, and behaviors), a laser range finder to determine distance, and a compass for bearing. These components are physically/electronically connected and synchronized to generate geo-referenced data for focal whales and vessels. Two integrated equipment packages are used to collect data simultaneously, with the first package dedicated to collecting data on killer whale behavior and location and the second package dedicated to collecting data on vessel behavior and location. Results from this study are not yet available, as the data from both 2007 and 2008 field seasons are still being analyzed.

Dr. John Hildebrand (University of California San Diego) and collaborators reported source level measurements for a variety of vessels of different sizes, propulsion systems, and operational speeds in Haro Strait. The researchers also opportunistically measured the source spectral levels of a 290 m long Korean container ship, the MV Hanjin Marseilles. The extended frequency range of vessel noise is pertinent to the higher frequency range of killer whale hearing and is particularly relevant to the reception of echolocation signals. Received levels were measured at ranges that varied between 125 and 442 meters for idle, normal cruise speed (17–31 knots), and power acceleration to full speed. Noise spectra were not sufficiently above background levels to make accurate measurements of vessel noise levels under controlled conditions while vessels were idle despite efforts to collect data when there were no other vessels present in the local vicinity. Thus data collected under idle conditions were not considered to be accurate measurements of real vessel noise. Noise source spectra measured from four whale watching vessels varied. For example, above 2 kHz, a 50-foot monohull whale watching vessel with three inboard/outboard (stern) drives produced the highest source spectral levels, while a 38-foot aluminum catamaran with jet drives produced the lowest source spectral levels. The catamaran presumably produced the lowest noise levels at higher frequencies because of its jet drive system. The MV Hanjin Marseilles produced significant levels of noise above 2 kHz, and with the exception of the 50-foot monohull vessel, these noise levels were higher than levels from whale watching vessels. These results demonstrate that noise generated by vessels is dependent on a combination of vessel size, engine type, and operating speed.

Dr. Marla Holt (NRC post-doctoral associate, NOAA NMFS NWFSC) wrote a comprehensive review on what is currently known about killer whale auditory capabilities, the use of sound by killer whales, the characteristics of sound in their environment, and the effects of sound exposure in killer whales and other dolphins in order to address potential acoustic impacts on the SRKW population. As is the case for all marine mammal groups, it is extremely difficult to address acoustic effects that might have indirect or small but consistent consequences at the population level. In this review, Dr. Holt, using data on spectral levels of vessels and Haro Strait ambient noise from Dr. Hildebrand's 2006 contract report, estimated the horizontal detection range of killer whales echolocating on Chinook salmon. She found that detection ranges varied by vessel type and mode of operation but that in general, boat noise generated by cruise and power up speeds at distances of up to 400 m from whales was predicted to significantly reduce the active space of an echolocation click at 50 kHz. These results demonstrate that vessel noise has the potential to impact echolocation abilities for foraging whales.

Publication: Holt, M.M. 2008. Sound exposure and Southern Resident killer whales (*Orcinus orca*): A review of current knowledge and data gaps. U.S. Dept. of Comm., NOAA Tech. Memo. NMFS-NWFSC-89, 59 p.

Available on-line: http://www.nwfsc.noaa.gov/assets/25/6741_03042008_154832_OrcaSoundExposureTM89Final.pdf

Given their dependence on sound and the many anthropogenic sources of noise in their core habitat, concerns have been raised about acoustic impacts on Southern Resident killer whales. A study by Dr. Marla Holt, and collaborators including NWFSC, Colorado College, and Beamreach researchers have found that SRKWs compensate for the masking effects of vessel noise by calling louder. These researchers found that whales increase their call level by one decibel for every decibel increase in background noise levels. Since calls are used for communication, it is not surprising that whales call louder as an anti-masking strategy when background noise levels are raised. The researchers also found that underwater noise levels increased as the number of motorized vessels around the whales increased, illustrating that vessel traffic contributes significantly to the background noise levels whales experience in their core habitat. Even though the whales can raise their voices when many vessels are present, there may be costs associated with that, or at some level, vessel noise could completely mask their calls. In this case, the range over which whales could communicate with one another would significantly decrease.

Peer-reviewed publication: Holt, M.M., Noren, D.P., Veirs, V., Emmons, C., and Veirs, S. 2009. Speaking up: Killer whales (Orcinus orca) increase their call amplitude in response to vessel noise. Journal of the Acoustical Society of America Express Letters 125: EL27-EL32.

Cumulative Risk Analysis

Understanding the relative contributions of different risk factors is essential for developing a sound recovery strategy. To start to evaluate the relative importance of different risks, Dr. Eric Ward (NOAA NMFS NWFSC) in collaboration with Dr. Eli Holmes (NOAA NMFS NWFSC) have initiated a project to use statistical approaches to examine the relationship between the whales' survival and birth rates and range of risk factors, including salmon abundance, the ocean environment, vessel interactions, and gross exposure to contaminants. Preliminary results suggest that the whales' birth rates are more strongly correlated with Chinook salmon abundance than they are with any of the other factors analyzed.

As Southern Resident killer whales pass the research vessel, scientists measure acoustic levels of their vocalizations, background noise levels, and vessel counts.

Southern Resident Killer Whales - Update on Recent Research Results

Human Dimension Studies

Southern Resident killer whales are subject to a host of pressures potentially complicit in their recent decline. Many of these pressures can be interpreted to be a result of human activity. Various NWFSC marine mammal research projects aim to better understand these pressures. In addition to the biological studies on the whales, the social sciences can inform the human connection to the whales. To better understand one connection between humans and whales, specifically in the whale watching tourism industry, Suzanne Russell (NOAA NMFS NWFSC) collected sociocultural data on marine mammal tourism linked to the Puget Sound SRKW population. Specifically, this study utilized a survey and interview tools to develop a baseline sociocultural description of the industry. Data collected included demographic information, employment history, and company characteristics. This information provides socioeconomic data that was previously absent, informs a discussion on socioeconomic impacts on the industry, and provides the foundation for future research.

Learn More & Come See us in Action

Sharing our work with other scientists, with policymakers, and with the public is important to us. To learn more about what we do, please visit our website at www.nwfsc.noaa.gov. To arrange a visit or obtain additional information, please call 206-860-3200.

Additional information on the killer whale research conducted and funded by the NWFSC's Marine Mammal Program for the past six years can be found on our website: http://www.nwfsc.noaa.gov/research/divisions/cbd/marine_mammal/marine-mammal.cfm

Appendix B

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

Task No.	Task Description	Priority	Responsible Parties	Comments	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
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	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
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										
1.2.1.1	Identify and prioritize specific sites in need of cleanup	2	CTC, NMFS, EC, DFO, EPA, WDOE, WDNR			100	30	40						

Task No.	Task Description	Priority	Responsible Parties	Comments	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
1.2.1.2	Remediate sites in need of cleanup	1	EPA, WDNR, potentially responsible/ liable parties, Superfund sites, See Appendix C	See 1.2										
1.2.2	Minimize continuing inputs of contaminants into the environment			See 1.2										
1.2.2.1	Minimize the levels of harmful contaminants discharged by industrial, municipal, and other point sources of pollution	3	WDOE, EPA, ODEQ, DFO, local/ municipal/ provincial	See 1.2										
1.2.2.2	Minimize the levels of harmful contaminants released by non-point sources of pollution	2	WDOE, EPA, ODEQ, DFO, local/ municipal/ provincial	See 1.2										
1.2.2.3	Reduce impacts to Southern Resident killer whales from emerging contaminants	3	WDOE, EPA, EC, local/ municipal	See 1.2										

Task No.	Task Description	Priority	Responsible Parties	Comments	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
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	Sound-watch, M3, NMFS	Ongoing, see also B.6.2.2	150	150	150	150	150	40	50	45	215	215
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				10	25					
1.3.2	Continue to evaluate and improve voluntary whale-watching guidelines	2	NMFS, M3, Sound-watch, DFO, NGO, WWOANW	Update guidelines in alternate years			10	20	8			6	20	

Task No.	Task Description	Priority	Responsible Parties	Comments	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
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	5	4	99		
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					20					
2	**Protect Southern Resident killer whales from additional threats that may cause disturbance, injury, or mortality, or impact habitat**													
2.1	Minimize the risk of large oil spills													
2.1.1	Prevent oil spills	1	USCG, WDOE, EC, industry associations	There are many ongoing oil spill programs including: Rescue Tug (1.44 million/yr) and ITOS (100K/yr)										

Task No.	Task Description	Priority	Responsible Parties	Comments	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
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 Contingen-cy Plan Wildlife Section Working Group, industry associations	One year task to develop Contingen-cy Plan and training in alternate years, FY is TBD									10	
2.1.3	Develop strategies to deter killer whales from entering spilled oil	2	NMFS, WDFW	One year project					22					
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	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
2.3	Continue to use agency coordination and established MMPA mechanisms to minimize any potential impacts from human activities involving acoustic sources, including Navy tactical sonar, seismic exploration, in-water construction, and other sources	2	NMFS	Ongoing actions include section 7 consulta-tions; no additional costs specific to killer whale listing or recovery currently identified										
2.4	Reduce the impacts of invasive species in Southern Resident habitats													
2.4.1	Prevent the introduction and spread of invasive species	3	WDFW, USFWS, NMFS, USCG, WDOA, ODEQ, DFO, industry associations	Washington State has ongoing invasives prevention program (2.5 million/yr)										

Task No.	Task Description	Priority	Responsible Parties	Comments	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
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	FY03-FY10 costs were for creation of a new orca exhibit and materials for SA and TWM	25	25	25	25	50	25	40	40	50	50

Task No.	Task Description	Priority	Responsible Parties	Comments	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
3.1.2	School programs	3	NGO, Tribes	FY05-FY10 costs for Killer Whale Tales, FY07-FY09 costs also for Springer Story and TWM Title 1			25	40	27	25	25	31	40	40
3.1.3	Naturalist programs	3	NGO, TWM	Naturalist training held March 2009						25			15	
3.1.4	Research programs	3	NWFSC, CWR, DFO and other researchers	Periodic research conferences, costs included under B.11										
3.2	Expand information and education programs to reduce direct vessel interactions with Southern Resident killer whales													

Task No.	Task Description	Priority	Responsible Parties	Comments	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
3.2.1	Expand the on-water educational efforts of Soundwatch, M3, and enforcement agencies	2	NMFS, Sound-watch, M3, WDFW, DFO	NMFS costs are included here and do not include JEA funds, additional costs are in 1.3.1.1	17	35	25	25	25	30	15	10	25	25
3.2.2	Outreach to private boaters	3	NMFS, Sound-watch, M3, WDFW, DFO, CG	Costs are included under 1.3.1.1					2					
3.2.3	Encourage land-based viewing of killer whales	3	TWM, Orca Relief, Lifeforce, WSP, NGO	Update program in alternate years				10		8	8	8		15
3.3	Educate public on positive actions they can take to improve the current condition for Southern Resident killer whales	2	NGO, NMFS	Some costs included under 3.1									25	25
3.4	Solicit the public's assistance in finding killer whales													
3.4.1	Solicit reports of killer whale sightings	3	NMFS, TWM, OrcaNet-work, CWR, BC Sighting Network	Costs included under B1.1		25	25		10					

Task No.	Task Description	Priority	Responsible Parties	Comments	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
3.4.2	Solicit reports of killer whale strandings from the public	3	NMFS, NMMSN, OrcaNet-work, CWR, BC Sighting Network	Education and outreach for NWMMSN program	2	2	2	2	1	2	3	5	2	2
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 rar 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	10									
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	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
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		10	10		20	15	10	
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	8	45		50						
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										

Task No.	Task Description	Priority	Responsible Parties	Comments	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
5.2.1	Plans are subject to periodic review	3	NMFS, DFO, WDFW	1 year task to update plan										50
5.2.2	Encourage public participation	3	NMFS, DFO, WDFW	1 year task to update plan		10		10						10
5.3	Inter-jurisdictional enforcement cooperation and coordination	3	NMFS, DFO, WDFW		15	10	15	25	30		15		20	20
				TOTALS	227	412	307	417	397	160	180	259	437	437
					TOTAL FY03-FY07			$1,760		TOTAL FY08-FY10		$599	FY11-FY12	$874

RESEARCH AND MONITORING

Task No.	Task Description	Priority	Responsible Parties	Comments	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
A	**Monitor status and trend of Southern Resident killer whales**													
A.1	Continue the annual population census	2	CWR		15	16	21	88	71	73	105	108	100	100
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 deter-mined										
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		90	285	290	290	336	156	151	164	775	775

Task No.	Task Description	Priority	Responsible Parties	Comments	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
B.1.2	Improve knowledge of distribution and movements in the Georgia Basin and Puget Sound	1	NWFSC, SWFSC, UW, TWM			31	95	29	64	31	42	55	200	200
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			34	103	94	79	74	61	42	8	190	190
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		31	29	83	68				130	130

Task No.	Task Description	Priority	Responsible Parties	Comments	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
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, researchers							79	50	33		
B.4.1	Assess the health of population members	2		Future costs TBD	50					20				
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		40	41	49	28				75	75
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	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
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		26	27						20	125	125
B.6.1.2	Assess changes in prey quality and their effects on Southern Resident population dynamics	1	NWFSC, UW										75	75
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	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
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													
B.6.2.1	Determine vessel characteristics that affect the Southern Residents	1	NWFSC, DFO, UW, researchers		112	202	95	116	63	85	25	109	150	150
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								22		
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								5		

Task No.	Task Description	Priority	Responsible Parties	Comments	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
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	88	50	10	25	68				175	175
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		60		40	40	40	40	40	40	135	135
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		30								

Task No.	Task Description	Priority	Responsible Parties	Comments	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
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						65					75	75
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	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
B.9	Determine genetic relationships		NWFSC, DFO, WFDW, researchers		105	65	67	40	37	24	12	14	100	100
B.9.1	Determine paternity patterns in the Southern Residents	2		Costs included under B.9										
B.9.2	Determine the risk of inbreeding	1		Costs included under B.9										
B.9.3	Determine historical population size	2		Costs included under B.9										
B.9.4	Determine genetic relationships among populations	2		Costs included under B.9				15						
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			10	10	10	43	64	50	62	50	50
B.11	Research support and coordination	2	NWFSC			208	212	131	342	24			175	175
				TOTALS	580	1098	1004	1060	1170	657	517	640	2530	2530
					TOTAL FY03-FY07			$4,912		TOTAL FY08-FY10		$1,814	TOTA FY11- FY12	$5,060