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Report on the Progress of Recovery Strategy Implementation for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada for the Period 2015 to 2019

Resident Killer Whale

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Canada

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Cover illustration Sheila Thornton. Fisheries and Oceans Canada. Northern Resident Killer Whales travelling.

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Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for the protection of species at risk throughout Canada. Under section 46 of the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the competent ministers are responsible for reporting on the implementation of the recovery strategy for a species at risk, and on the progress towards meeting its objectives within five years of the date when the recovery strategy was placed on the Species at Risk Public Registry and in every subsequent five-year period, until its objectives have been achieved or the species' recovery is no longer feasible.

Reporting on the progress of recovery strategy implementation requires reporting on the collective efforts of the competent minister(s), provincial and territorial governments and all other parties involved in conducting activities that contribute to the species' recovery. Recovery strategies identify broad strategies and approaches that will provide the best chance of recovering species at risk. Some of the identified strategies and approaches are sequential to the progress or completion of others and not all may be undertaken or show significant progress during the timeframe of a Report on the Progress of Recovery Strategy Implementation (progress report).

The Minister of Fisheries and Oceans and the Minister responsible for the Parks Canada Agency (PCA) are the competent ministers under SARA for the Northern and Southern Resident Killer Whales and have cooperated in the development of this progress report.

As stated in the preamble to SARA, success in the recovery of species at risk depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in the recovery strategy and will not be achieved by Fisheries and Oceans Canada and the PCA, or any other jurisdiction alone. The cost of conserving species at risk is shared amongst different constituencies. All Canadians are invited to join in supporting and implementing the recovery strategy for the Northern and Southern Resident Killer Whales for the benefit of the species and Canadian society as a whole.

Acknowledgments

This progress report was prepared by Alannah Biega (DFO) and to the extent possible with input from: DFO Science, Fisheries Management, Conservation and Protection, and Ecosystem Management branches; Parks Canada Agency; Environment and Climate Change Canada; Transport Canada; National Oceanic and Atmospheric Administration; British Columbia Ministry of Environment and Climate Change Strategy; Metro Vancouver; University of Victoria; the Port of Vancouver; and Ocean Wise Conservation Association. Fisheries and Oceans Canada would also like to express its appreciation to all individuals and organizations who have contributed to the recovery of Northern and Southern Resident Killer Whales.

Executive summary

Two populations of Resident Killer Whales (*Orcinus orca*) inhabit the coastal waters of British Columbia. These two populations, known as the Northern and Southern Residents, have overlapping ranges but are acoustically, genetically, and culturally distinct from each other. Since 2003, the Northern and Southern Resident Killer Whales have been listed in Schedule 1 of the *Species at Risk Act* (SARA), as threatened and endangered respectively. The "Recovery Strategy for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada" was finalized and published on the Species at Risk Public Registry in 2008, amended in 2011 to clarify critical habitat attributes, and amended again in 2018 to include two additional areas of critical habitat.

The principal threats identified in the recovery strategy for Northern Resident Killer Whales (NRKW) and Southern Resident Killer Whales (SRKW) include: reduced prey availability, environmental contaminants, and physical and acoustic disturbance. An additional emerging threat, vessel strikes, was identified during a science-based review of recovery actions for SRKW (DFO 2017d).

The recovery goal for NRKW and SRKW is to ensure the long-term viability of Resident Killer Whale populations by achieving and maintaining demographic conditions that preserve their reproductive potential, genetic variation, and cultural continuity. In order to achieve this goal, the recovery strategy identifies four recovery objectives that address the principal anthropogenic threats: 1) ensure that Resident Killer Whales have an adequate and accessible food supply to allow for recovery; 2) ensure that chemical and biological pollutants do not prevent the recovery of Resident Killer Whale populations; 3) ensure that disturbance from human activities does not prevent the recovery of Resident Killer Whales; and 4) protect critical habitat for Resident Killer Whales and identify additional areas for critical habitat designation and protection.

The "Report on the Progress of Recovery Strategy Implementation for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada for the Period 2015 to 2019" reports on progress made from 2015 to the end of 2019 towards implementing the recovery strategy and achieving its objectives, including progress made by Fisheries and Oceans Canada and its partners, along with other federal agencies, and highlights some of the known achievements of the broader conservation community. This work would not have been possible without the extraordinary partnerships formed to support Resident Killer Whale recovery. During this period, notable progress towards meeting the objectives set out in the recovery strategy has been made through the following:

- completed an Imminent Threat Assessment for SRKW and determined that SRKW likely face an imminent threat to recovery and survival unless current threats are mitigated; this resulted in increased funding to support recovery through initiatives included in the $1.5 billion Oceans Protection Plan to support cleaner, healthier and safer oceans, and the $167.4 million Whales Initiative directed towards the recovery of endangered whale populations, including SRKW, and a further investment of $61.5 million over five years to address principal anthropogenic threats to SRKW
- provided additional funds through the $55 million Canada Nature Fund for Aquatic Species at Risk to projects that help mitigate marine priority threats, with direct benefits to SRKW and NRKW

- established four threat-based technical working groups and one advisory working group to support the development of enhanced management measures for protecting and recovering SRKW
- enhanced seasonal management measures starting in 2019 to support recovery of SRKW which included mandatory fishing restrictions, Interim Sanctuary Zones, and an increased approach distance for Killer Whales to 400 metres (m) in areas of SRKW critical habitat
- amended critical habitat to include two additional areas: 1) waters on the continental shelf off southwestern Vancouver Island, including Swiftsure and La Perouse Banks for NRKW and SRKW; and 2) waters west of Dixon Entrance along the north coast of Graham Island from Langara to Rose Spit for NRKW
- continued monitoring of NRKW and SRKW populations through dedicated annual censuses and sighting networks
- amended the *Fisheries Act*'s *Marine Mammal Regulations* requiring a minimum approach distance of 200 m to all Killer Whales in Canadian Pacific waters and adding a definition of disturbance to marine mammals
- developed and implemented a "*Species at Risk Act* Section 11 Conservation Agreement to Support the Recovery of the Southern Resident Killer Whale" with the Vancouver Fraser Port Authority (VFPA) and six other member organizations of the VFPA-led Enhancing Cetacean Habitat and Observation (ECHO) Program, signed on May 10, 2019 and covering a five-year period following that date (2019 to 2024)
- initiated a voluntary inshore lateral displacement trial through the ECHO Program in the Strait of Juan de Fuca to move large commercial ships as well as inshore traffic, such as tugs and barges, farther away from known and suspected whale foraging areas
- strengthened science, notably new research on the cumulative impact of different threats to NRKW and SRKW recovery
- expanded underwater acoustic monitoring systems and improved technologies to detect whales and measure vessel noise
- held technical workshops with Killer Whale and Salmon scientists and managers to identify and evaluate short-term management actions that might increase the immediate abundance and accessibility of Chinook Salmon for SRKW
- undertook management actions towards increasing prey availability by reducing fisheries for Chinook Salmon, restoring coastal salmon habitat, closing fisheries in key foraging areas to allow better feeding opportunities, and the release of additional hatchery Chinook
- increased monitoring and research on the sources and impacts of contaminants on whales and their prey

Significant progress has been made toward meeting the objectives and strategies outlined in the recovery strategy. The NRKW population has grown at a mean annual rate of 1.4% between 2015 and 2019 (DFO 2020a, 2020b), while the SRKW population has decreased from 81 to 73 individuals over that same time period (Center for Whale Research 2021). As Resident Killer Whales are long-lived with low reproductive rates and a multitude of threats with cumulative effects, ongoing work is required to support the recovery of these populations.

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1. Introduction

The “Report on the Progress of Recovery Strategy Implementation for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada for the Period 2015 to 2019” (progress report) outlines the progress made towards meeting the objectives listed in the “Recovery Strategy for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada” (DFO 2018b) from 2015 through to the end of 2019 and should be considered as part of a series of documents for these two populations that are linked and should be taken into consideration together; including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report (COSEWIC 2008), the “Action Plan for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada” (DFO 2017a), the critical habitat orders for Northern Resident and Southern Resident Killer Whales respectively (Justice Canada 2018a, 2018b), and the “Report on the Progress of Recovery Strategy Implementation for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada for the Period 2009 to 2014” (DFO 2016).

Section 2 of the progress report reproduces or summarizes key information on the threats to the populations and their critical habitat and objectives for achieving their recovery. For more details, readers should refer to the “Recovery Strategy for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada”. Section 3 reports on implemented activities associated with performance measures that provide a way to define and measure progress towards achieving the recovery objectives. Section 4 summarizes the progress toward achieving the objectives through 2019.

2. Background

2.1 COSEWIC assessment summary and threats to the species and its critical habitat

Northeast Pacific southern resident population and Northeast Pacific northern resident population, also known as Northern and Southern Resident Killer Whales (NRKW and SRKW respectively), were initially assessed and designated as threatened by COSEWIC in 1999 (Baird 1999). In 2001, COSEWIC re-examined and confirmed the status of NRKW as threatened, while changing the status of SRKW to endangered (COSEWIC 2001). The listing of NRKW and SRKW under the *Species at Risk Act* (SARA) in 2003 that led to the development and publication of the “Recovery Strategy for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada” in 2008 was based on the information provided in COSEWIC (2001).

In 2008, COSEWIC re-examined and confirmed the status of SRKW as endangered and NRKW as threatened (COSEWIC 2008). The latest COSEWIC assessment summaries are provided below.

Common name: Killer Whale, Southern Resident population

Scientific name*: Orcinus orca*

Status: Endangered

Reason for designation: The population is small and declining, and the decline is expected to continue. Southern Residents are limited by the availability of their principal prey, Chinook Salmon. There are forecasts of continued low abundance of Chinook Salmon. Southern Residents are also threatened by increasing physical and acoustical disturbance, oil spills and contaminants.

Occurrence: Pacific Ocean

Status history: The "North Pacific resident populations" were given a single designation of threatened in April 1999. Split into three populations in November 2001. The Southern Resident population was designated endangered in November 2001. Status re-examined and confirmed in November 2008.

Assessment Summary, November 2008

Common name: Killer Whale, Northern Resident population

Scientific name*: Orcinus orca*

Status: Threatened

Reason for designation: The population is small and is limited by the availability of its principal prey, Chinook Salmon. It is also at risk from physical and acoustical disturbance, oil spills and contaminants. However, this population has been increasing slowly but steadily since monitoring began in 1975.

Occurrence: Pacific Ocean

Status history: The "North Pacific resident populations" were given a single designation of threatened in April 1999. Split into three populations in November 2001. The Northern Resident population was designated threatened in November 2001. Status re-examined and confirmed in November 2008.

The "Recovery Strategy for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada" identifies the threats to survival and recovery of NRKW and SRKW and their critical habitat. These threats include: reduced prey availability, environmental contaminants (including oil spills), and physical and acoustic disturbance. Please refer to section 4 of the recovery strategy for more information on these threats (DFO 2018b).

Critical habitat for NRKW and SRKW was identified to the extent possible in section 3 of the 2008 recovery strategy. In 2011, the recovery strategy was amended to clarify the attributes of critical habitat (DFO 2011) and then amended again in 2018 to include two additional areas identified as critical habitat for Resident Killer Whales (DFO 2018b). The recovery strategy also provides examples of activities that are likely to result in destruction to critical habitat if unmitigated. The list of activities provided in table 6 of the recovery strategy is neither exhaustive nor exclusive, and their inclusion has been guided by the relevant threats described in the recovery strategy. For more details on the activities likely to result in the destruction of critical habitat, consult the recovery strategy.

2.2 Recovery

This section summarizes the information, found in the recovery strategy (DFO 2018b), on the objectives that are necessary for the recovery of NRKW and SRKW.

Section 6 of the recovery strategy identified the following recovery goal:

> Ensure the long-term viability of Resident Killer Whale populations by achieving and maintaining demographic conditions that preserve their reproductive potential, genetic variation, and cultural continuity.

The recovery goal reflects the complex social organization and mating strategies of Resident Killer Whales and the key threats that may be responsible for their decline. In order to achieve this goal, the recovery strategy identified four recovery objectives. These include:

> Objective 1: ensure that Resident Killer Whales have an adequate and accessible food supply to allow recovery.
>
> Objective 2: ensure that chemical and biological pollutants do not prevent the recovery of Resident Killer Whale populations.
>
> Objective 3: ensure that disturbance from human activities does not prevent the recovery of Resident Killer Whales.
>
> Objective 4: protect critical habitat for Resident Killer Whales and identify additional areas for critical habitat designation and protection.

Each recovery objective is associated with broad strategies that can be used to mitigate each of the threats facing RKW. Section 6.4 of the recovery strategy provides examples of performance measures that are aligned with these broad strategies and that may be used to define and measure progress toward achieving the recovery objectives listed above. However, sufficient data for some measures was not acquired within the timeframe covered in this progress report. In such cases, reporting on the implementation of activities relating to the performance measures and critical habitat studies will help inform progress towards achievement of the recovery objectives.

3. Progress towards recovery

The recovery strategy for Resident Killer Whales (DFO 2018b) provides examples of performance measures that may be used to define and measure progress toward achieving the recovery objectives. Section 3.1 reports on the implementation of activities associated with each performance measure in support of these recovery objectives. Section 3.2 reports on the activities identified in the schedule of studies to identify critical habitat. Section 3.3 reports on the progress on meeting the recovery objectives and other commitments (for example, action plan and critical habitat order) identified in the recovery strategy and information obtained through implementing the recovery strategy.

3.1 Activities supporting recovery

Table 1 provides information on the implementation of activities undertaken to address the performance measures identified in the recovery strategy. The implementation of these activities helps to address the broad strategies and recovery goal and objectives identified in the recovery strategy.

Table 1. Details of activities supporting the recovery of Northern and Southern Resident Killer Whales from 2015 to 2019. For each performance measure, the activity description and results are reported in the following order where applicable: i) activities relevant to both populations, ii) activities relevant solely to NRKW, and iii) activities relevant solely to SRKW.

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
Completion of annual censuses	Monitor population dynamics and demography	• Population censuses by photo-identification have been conducted by Fisheries and Oceans Canada (DFO) on Northern Resident Killer Whales (NRKW) each year since 1973 (DFO 2020b). Photo identification catalogues for NRKW are maintained and updated periodically by DFO (see Towers et al. 2020). • With support from the National Oceanic and Atmospheric Administration (NOAA), annual censuses for Southern Resident Killer Whales (SRKW) are led by the Center for Whale Research, with DFO contributing photographs to further support this effort each year (Doniol-Valcroze pers. comm. 2020; Hanson pers. comm. 2020). Since 2019, the Parks Canada Agency (PCA) contributes photographs taken in waters within and adjacent to park reserve marine waters in Pacific Rim National Park Reserve to support annual census efforts for SRKW (Kroeker pers. comm. 2021)[1]. Photo identification catalogues for SRKW continue to be maintained and updated (Center for Whale Research 2019).	Recovery goal: achieve and maintain demographic conditions that preserve the reproductive potential, genetic variation, and cultural continuity of Northern and Southern Resident Killer Whales	Center for Whale Research, DFO, NOAA, PCA
Genetic sampling and analyses completed	Monitor population dynamics and demography	• Biopsy samples of Resident Killer Whale (RKW) are collected opportunistically by Ocean Wise Conservation Association (Ocean Wise) during their photogrammetry study. Between 2015 and 2019, 13 biopsies were collected from NRKW (Noel pers. comm. 2020; Barrett-Lennard pers. comm. 2020). Between 2015 and 2016, 18 biopsies were collected from SRKW (Barrett-Lennard pers. comm. 2019). In collaboration with DFO, biopsy samples are	Recovery goal: achieve and maintain demographic conditions that preserve the reproductive	**Ocean Wise,** DFO, NOAA

[1] In 2020, photographs were also provided from waters within and adjacent to park reserve marine waters in Gulf Islands National Park Reserve.

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		analyzed for contaminants, stable isotopes, genetics, and nutritional analysis (Thornton pers. comm. 2020).	potential, genetic variation, and cultural continuity of Northern and Southern Resident Killer Whales	
Evaluation of population status to ensure growth	Monitor population dynamics and demography	• As of 2019, the best population estimate for NRKW was 310 individuals. Between 2015 and 2019, annual NRKW population growth rates have ranged from 2.8% in 2015 to 0.3% in 2018, but overall grew at a mean annual rate of 1.4% over this five year period. The annual growth rate in 2019 was 2.6% (DFO 2020b). • SRKW have undergone periods of growth and decline. Since 1974, the number of individuals has fluctuated from 71 (in 1974) to 96 (in 1996) (DFO 2017d). As of December 31, 2019 the SRKW population totals 73 individuals (Center for Whale Research 2019)[2]. • SRKW annual population size, based on data released by the Centre for Whale Research, is one of 10 reported Canada-United States (US) Transboundary Salish Sea Ecosystem Health Indicators (United States Environmental Protection Agency 2021). The next published update to the Transboundary Salish Sea Ecosystem Health Indicators (including the SRKW Indicator) is in 2021.	Recovery goal: achieve and maintain demographic conditions that preserve the reproductive potential, genetic variation, and cultural continuity of Northern and Southern Resident Killer Whales	Center for Whale Research, DFO, NOAA
Models developed that incorporate social and genetic structure and explain population trends	Develop population models	• Killer Whales have a matrilineal social system, meaning that a female, her offspring, and her daughter's offspring will stay together for life (this family unit is referred to as a matriline). A study by Croft et al. (2017) demonstrated that because Killer Whale offspring stay with their mothers for life, they become more related to the other females and males in their matriline as they age. Younger females that invest more in competition have greater reproductive success than older females (their mothers).	Recovery goal: achieve and maintain demographic conditions that preserve the reproductive potential, genetic	**Academia,** DFO, NOAA

[2] As of December 31, 2020, the SRKW populations totals 74 whales (Center for Whale Research 2021).

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		This conflict, combined with the benefits provided by post-reproductive females to their children and grandchildren can explain why female Killer Whales continue to live long after they have stopped reproducing (Croft et al. 2017). • An assessment was undertaken to determine drivers of matriline splitting (fission) in NRKW and how it may be influenced by intragroup food competition and prey abundance (Stredulinsky 2016).[3] • A study by Ellis et al. (2017) examined the relationship between social position and mortality risk in SRKW. They found that the social position of male, but not female, Killer Whales in their social unit predicts mortality risk. More socially integrated males have a significantly lower risk of mortality than socially peripheral males, suggesting social position mediates access to resources.	variation, and cultural continuity of Northern and Southern Resident Killer Whales	
Models completed that incorporate threats into population dynamic models	Quantitative framework for understanding effects of threats on population dynamics	• Building on a previous model developed by Lacy et al. (2017), DFO Science developed a model that quantitatively assessed the effects of the priority threats on the population trajectories of RKW (Murray et al. 2019). This research addresses a high priority recovery measure in the action plan to "assess cumulative effects of potential anthropogenic impacts on Resident Killer Whales using an appropriate impact assessment framework for aquatic species" and highlights the importance of considering threats collectively. Outputs from the cumulative effects model with all threats represented (prey abundance, contaminants, vessel noise/presence, and vessel strikes) were closer to the observed population sizes than any of the single threat models alone. These model outputs indicate that if no further management measures are undertaken, the average modelled NRKW population trajectory increases to the carrying capacity set in the model within	Recovery goal: achieve and maintain demographic conditions that preserve the reproductive potential, genetic variation, and cultural continuity of Northern and Southern Resident Killer Whales	**Academia, DFO**

[3] Further analysis of NRKW social associations using photo-identification data revealed that NRKW matriline fission is best predicted by intragroup competition for food, leadership experience, and kinship (Stredulinsky et al. 2021). This model would predict that more competition for food would result in a higher likelihood of matriline splitting.

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		25 years, under current prey abundance conditions. In contrast, the average modelled SRKW population trajectory declines, with a 26% probability of population extinction, and in those projections, mean time to extinction was 86 years under the assumption of no further management action (Murray et al. 2019)[4]. While this analysis does not include estimates of potential biological removal for NRKW and SRKW, this model was an important step towards assessing these populations in terms of growth/extinction going into the future (Doniol-Valcroze pers. comm. 2020).		
Peer-reviewed publications on role of culture in Killer Whale	Studies to identify role of culture in foraging ecology and sociobiology	• Nattrass et al. (2019) found that post-reproductive grandmothers provide significant survival benefits to their grand-offspring above those provided by reproductive grandmothers. This benefit was most important in times where salmon abundance was low, and can help explain why female RKW can live decades after stopping reproduction. • Using a long-term dataset on SRKW, Brent et al. (2015) reported that post-reproductive females lead groups during collective movement in salmon foraging grounds and that leadership by post-reproductive females is especially prominent in difficult years when salmon abundance is low. • Non-invasive, multi-sensor archival tags (DTAGs) attached by suction cups to SRKW demonstrated males made significantly more prey-capture dives than females and more dives to the depth range of their preferred prey, Chinook Salmon (Tennessen et al. 2019).	Recovery goal: achieve and maintain demographic conditions that preserve the reproductive potential, genetic variation, and cultural continuity of Northern and Southern Resident Killer Whales	**Academia,** NOAA
Biopsy samples collected and analyzed to identify paternity	Studies to identify role of culture in maintaining	• Ocean Wise has developed a new method to rapidly genotype biopsy and fecal samples by sequencing single nucleotide polymorphism sites. They are currently genotyping existing NRKW biopsy samples using this method, enabling them to match fecal samples to the correct Killer Whale, as well as add to their existing	Recovery goal: achieve and maintain demographic conditions that	**NOAA, Ocean Wise,** Center for Whale Research

[4] There are data limitations and uncertainties for each of the principal threats to RKW (prey availability, acoustic disturbance, physical disturbance, and contaminants) and their impacts on mortality and birth rates. An iterative, adaptive approach should be taken to update the cumulative effects model as new data become available and as data about other potential threats emerge (Murray et al. 2019).

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
	genetic diversity	NRKW microsatellite dataset to determine paternity and assay mating performance (Barrett-Lennard pers. comm. 2020). • Ford et al. (2018) analyzed genetic data from 105 SRKW and reported that only two adult males sired 52% of calves born since 1990 and four sampled calves were the product of an inbred mating. No evidence of inbreeding avoidance was found in the population. Inbreeding is likely common, but whether this has any effect on fitness is uncertain.	preserve the reproductive potential, genetic variation, and cultural continuity of Northern and Southern Resident Killer Whales	
Prey fragment samples collected year-round for multiple years	Determine seasonal/ annual diet/ energetic requirements	• Prey sampling continues for both populations, year-round where possible but biased towards summer months (Doniol-Valcroze pers. comm. 2020). Sample collection includes prey scales and tissues from predation events. Salmon species and stock identification from these samples continues on an annual basis for SRKW and NRKW (Doniol-Valcroze pers. comm. 2020; Thornton pers. comm. 2020). Results from prey analysis are reported on in more detail under the performance measures below. • NOAA researchers continue to collect samples of prey scales and tissues from predation events during encounters with SRKW (Hanson pers. comm. 2020).	Objective 1: ensure that Resident Killer Whales have an adequate and accessible food supply to allow recovery	**DFO,** NOAA
Alternative diet sampling methods tested to confirm diet	Determine seasonal/ annual diet/ energetic requirements	• Estimating diet has also been completed using DNA from Killer Whale feces. Fecal samples from SRKW and NRKW were collected in 2018 and 2019. Analysis of prey species from fecal DNA is currently underway and data from each population will be compared (Thornton pers. comm. 2020). • Stomach contents are collected opportunistically during necropsies to inform diet (Cottrell pers. comm. 2020). • Ford et al. (2016) analyzed 175 fecal samples from SRKW and determined that salmonids made up over 98% of the inferred diet, with Chinook Salmon making up the majority.	Objective 1: ensure that Resident Killer Whales have an adequate and accessible food supply to allow recovery	Academia, British Columbia (BC) Ministry of Agriculture, Food, and Fisheries (MoAFF), DFO, NOAA, Ocean Wise
Winter and spring	Determine seasonal/	• Sightings of RKW are recorded and prey samples are collected opportunistically during multi-species surveys and year-round	Objective 1: ensure that Resident Killer	**DFO, NOAA,**

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
distribution and diet of Resident Killer Whales identified	annual diet/ energetic requirements	monitoring conducted by DFO (Doniol-Valcroze pers. comm. 2020). • Analyses of SRKW prey confirm that Chinook Salmon make up the majority of SRKW diet throughout the year (Wright pers. comm. 2020). • Winter prey sampling of SRKW occurs opportunistically during encounters by NOAA researchers along with other collaborators (Hanson pers. comm. 2020). SRKW diet is generally dominated by Chinook Salmon year-round but is more diverse in non-summer months (Hanson et al. 2021).	Whales have an adequate and accessible food supply to allow recovery	PCA
Complete diet sampling of all members of population and during all seasons	Identify key prey populations and feeding areas	• Salmon species and stock identification from prey fragments continues on an annual basis (Doniol-Valcroze pers. comm. 2020). A total of 201 predation events, 184 of which had confirmed prey species identification, were documented for RKW in western Juan de Fuca Strait and off southwestern Vancouver Island during 2003 to 2013. Of these, 180 (98%) were salmonids, with Chinook Salmon being the predominant species representing 88% of all prey items sampled. Other salmonid prey species included Coho (5%), Chum (3%), Steelhead (1%) and Sockeye (0.5%) (Ford et al. 2017). • More recently, 149 prey samples from RKW predation events were collected coast wide between 2015 and 2018 and identified to species. Of these, 78% were Chinook, 19.5% Chum, 2% Sockeye, and ~1% Steelhead (DFO unpublished data).	Objective 1: ensure that Resident Killer Whales have an adequate and accessible food supply to allow recovery	**DFO**
Prey identified to stock, not just species	Identify key prey populations and feeding areas	• DFO genetically analyzed scales and/or tissue fragments of Chinook Salmon from RKW predation events to identify stock and region of origin. Fraser River stocks comprised 80% of the Chinook Salmon eaten by NRKW and SRKW off southwestern Vancouver Island and western Dixon Entrance, with South Thompson being the predominant stock (44%), followed by stocks from rivers in Puget Sound (13%) and along the west coast of Vancouver Island (6%) (Ford et al. 2017).	Objective 1: ensure that Resident Killer Whales have an adequate and accessible food supply to allow recovery	**DFO, NOAA**

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		• In 2018, NOAA Fisheries issued a paper on priority Chinook Salmon stocks for SRKW. NOAA Fisheries' West Coast Region and Northwest Fisheries Science Center worked with the Washington Department of Fish and Wildlife to develop the list and model using the best and latest research on SRKW and their prey, including prey and scat sampling analyses (NOAA Fisheries West Coast Region and Washington Department of Fish and Wildlife 2018).		
Population assessment completed for all stocks identified as important prey for Resident Killer Whales	Monitoring prey populations to detect changes in abundance or availability	• DFO, often in collaboration with partners, deliver three area-based types of monitoring programs annually to support salmon stock assessment: population monitoring, catch monitoring, and ecosystem monitoring (DFO 2019b). • Annually, escapement surveys are completed for Chinook indicator stocks associated with the stock management units that RKW are most likely to prey on. These surveys provide an index of the population spawning abundance. The overall returns (spawning abundance and catch) of these indicator stocks are indexed annually using the results of various catch monitoring and sampling programs in addition to escapement surveys (Dobson pers. comm. 2020).	Objective 1: ensure that Resident Killer Whales have an adequate and accessible food supply to allow recovery	**DFO**
Guidelines developed for human activities in important whale feeding areas	Protect access to important feeding areas	• The *Marine Mammal Regulations* under the *Fisheries Act* minimize disturbance from vessels to RKW. The last amendment in 2018 includes the introduction of a general minimum approach distance of 200 m for all Killer Whales found in Canadian Pacific waters. The amended *Marine Mammal Regulations* now define disturbance to marine mammals as approaching, attempting to feed, swimming or interacting with, moving, enticing or causing movement, separating from groups/calves, trapping, tagging or marking. They also require reporting any accidental contact between a marine mammal and a vessel or fishing gear (Justice Canada 2018c). • Be Whale Wise (BWW) is a partnership of governmental agencies, Environmental Non-Governmental Organizations (ENGOs) and other stakeholders in the Salish Sea to research, implement, and	Objective 1: ensure that Resident Killer Whales have an adequate and accessible food supply to allow recovery	**DFO,** ENGOs, NOAA, PCA

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		educate best vessel practices around whales (Be Whale Wise 2019). DFO provides information about the BWW guidelines to stakeholders, the fishing industry, ENGOs working on the water, and members of the public. • The PCA is working towards minimizing disturbance to marine mammals from visitor boats by promoting compliance with BWW guidelines through visitor orientations, business licencing, web, social media, and public outreach and education events and programs. SRKW messaging is also included in interpretive programs at Gulf Islands National Park Reserve, Pacific Rim National Park Reserve and through the Coastal Naturalist Program in partnership with BC Ferries (Kroeker pers. comm. 2021). Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve and Haida Heritage Site also promote compliance with BBW guidelines, including messaging about SRKW and NRKW (Lee pers. comm. 2021). • In 2019, under the *Canada Shipping Act's* Interim Order, an approach distance of 400 m to Killer Whales was in effect between June 1 and October 31 within SRKW critical habitat (DFO 2019a). Exceptions were made for authorized vessels (including commercial whale watchers) to be closer (up to 200 m) to Killer Whales that are not SRKW (DFO 2019a). The Interim Order was also put in place in subsequent years. • Voluntary measures were also implemented from May to October 2019, including avoiding fishing when within 1,000 m of Killer Whales in Enhanced Management Areas (which represent key foraging areas for SRKW), and encouraging boaters to slow down to 7 knots or less, turn off echo sounders if not in use, and turn engines to neutral idle when within 1,000 m of Killer Whales in SRKW critical habitat.		
Incorporation of Killer Whale predation into	Protection of prey populations	• Under the 2018 to 2023 Whales Initiative (Government of Canada 2018d) and a further investment of $61.5 million to address principal anthropogenic threats to SRKW, four technical working	Objective 1: ensure that Resident Killer Whales have an	**DFO,** Academia

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
fisheries management plans		groups and one Enhancing Cetacean Habitat and Observation (ECHO) Program advisory working group were established to support the development of management measures for protecting and recovering SRKW. The focus of one of these groups is prey availability. In 2018, Chinook fisheries in BC were reduced by an estimated 25 to 35% to help increase prey availability for RKW (DFO 2018c). In 2019, the suite of SRKW management measures included area-based fishing closures for recreational and commercial salmon from August to October 2019, and a voluntary fishery avoidance zone within 1,000 m of Killer Whales within key foraging areas (DFO 2019a)[5]. • Commercial fisheries Integrated Fisheries Management Plans now provide text to raise awareness and encourage compliance with measures to increase prey availability for SRKW. In 2018, this included text on SRKW fisheries management measures for recreational finfish and commercial salmon area-based closures in place from June 1 through September 30 (DFO 2018c). In 2019, this included text on fishing restrictions, Interim Sanctuary Zones, increased approach distance for Killer Whales, and a fishing avoidance zone within 1,000 m of Killer Whales (DFO 2019f). • In 2017, the Marine Mammal Research Unit at the University of British Columbia (UBC) held a technical workshop on the availability of prey for SRKW. This workshop assembled scientists and managers with technical expertise on Killer Whales and Chinook Salmon to identify and evaluate short-term management actions that might increase the immediate abundance and accessibility of Chinook salmon for SRKW (Trites and Rosen 2018). Output from this workshop helped inform fisheries management measures taken for 2018 in support of threat abatement and recovery of SRKW. • In 2019, two workshops were held to identify knowledge and uncertainties about the diets and population dynamics of	adequate and accessible food supply to allow recovery	

[5] SRKW management measures were updated and in effect again in 2020 and 2021 (DFO 2019a).

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		pinnipeds, including possible impacts of pinnipeds on salmon in the Salish Sea (Trites and Rosen 2019) and potential management actions (Trzcinski 2020).		
Peer reviewed publication on contaminants in Resident Killer Whales	Investigate effects of contaminants on health and reproductive capacity of Killer Whales	• Desforges et al. (2018) used statistical models to show that blubber polychlorinated biphenyl (PCB) effects on reproductive and immune function could threaten the viability of >50% of the world's Killer Whale populations. NRKW were assessed as having a low population-level risk from PCB exposure, SRKW as moderate, and Transient (mammal-eating) Killer Whales as high. Overall, females exhibit lower blubber PCB levels than males because of maternal sequestration to young during fetal development and lactation (Desforges et al. 2018). • Hall et al. (2018) used statistical models to assess the effects of PCBs on calf survival and immunity in RKW. They estimate that the impacts of PCBs on adult survival (with immunocompromised individuals showing vulnerability to novel pathogens) is one of the factors constraining recovery of SRKW. • A food web bioaccumulation model was designed to estimate polybrominated diphenyl ethers (PBDE) concentrations in Killer Whales based on PBDE concentrations in sediments and the water column throughout a lifetime of exposure (Alava et al. 2016). Calculated and observed PBDE concentrations exceeded the only toxicity reference value available for PBDEs in marine mammals (1500 µg/kg lipid) (Hall et al. 2003) in SRKW but not in NRKW (Alava et al. 2016). • A conceptual framework was developed to evaluate the impacts of potential oil exposure on 21 species of marine mammals inhabiting coastal BC. Vulnerability was deemed highest for NRKW and SRKW and Sea Otters, followed by Transient Killer Whales and Steller Sea Lions (Jarvela Rosenberger et al. 2017). • A cumulative effects model considered the effects of PCB contaminants in combination with other threats (reduced Chinook Salmon abundance, vessel noise/physical presence, and vessel	Objective 2: ensure that chemical and biological pollutants do not prevent the recovery of Resident Killer Whale populations.	**Academia,** DFO, NOAA

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		strike) on the population trajectories of RKW (Murray et al. 2019). Results suggest that Chinook Salmon abundance and its interactions with vessel noise and PCBs strongly influenced modelled Killer Whale population dynamics (Murray et al. 2019). • In 2016, NOAA released a technical memorandum on the implication of toxic chemicals on the health of SRKW (Mongillo et al. 2016).		
Develop and apply tests to measure the health of Killer Whales	Investigate effects of contaminants on health and reproductive capacity of Killer Whales	• Based on a food web bioaccumulation model, Alava et al. (2016) recommend that a PBDE concentration in sediments of approximately 1.0 µg/kg dry weight produces a PBDE concentration in RKW that is below the current toxicity reference value for 95% of the population, with this value serving as a benchmark for a management-based approach to reducing health risks. • Since 2018, DFO has collected 88 fecal samples from NRKW and 57 samples from SRKW (Thornton pers. comm. 2020). These samples are being used to support numerous studies and develop new methodologies to measure the health of Killer Whales. Aliquots of these samples have been provided in support of collaborative studies with NOAA (microbiome) and University of Washington (inter-lab hormone analysis) (Thornton pers. comm. 2020). • Assessment of fecal corticosteroid and sex hormone levels in both populations (including pregnancy rates) is currently underway and supports a UBC graduate research in collaboration with DFO and Ocean Wise (Thornton pers. comm. 2020). • DFO is developing of non-invasive health assessment tools for RKW. Fecal samples from both populations are currently being analyzed for metabolite concentrations to evaluate health and the data will support both nutritional and stress analyses and contaminants research (Thornton pers. comm. 2020; Brown pers. comm. 2020). A subset of 25 of these samples have been analyzed for PCBs, PBDEs, Hexabromocyclododecane,	Objective 2: ensure that chemical and biological pollutants do not prevent the recovery of Resident Killer Whale populations.	**DFO,** Academia, BC MoAFF, NOAA, Ocean Wise

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		Dioxin/Furans. Archived skin samples from Transient Killer Whales and RKW are also being analyzed for metals (including mercury and methylmercury) and stable isotopes to look at temporal trends in diet and contaminant concentrations. Health assessments in relation to contaminant burden (for example, mercury) are being assessed in these individuals (Brown pers. comm. 2020). • On-going photogrammetry efforts by NOAA and Ocean Wise since 2014 have documented body condition of SRKW and NRKW (Matkin et al. 2017; Fearnbach et al. 2018). The project uses a drone to take overhead images of Killer Whales. From these photographs, body measurements can be taken and used to document changes in physical condition and nutritional status. Photogrammetry data collected between 2014 and 2017 have provided evidence that growth and adult length have been constrained in NRKW. Adult males between 20 and 40 years old have significantly shorter body lengths than those over 40 years old, suggesting that younger adults experienced constrained growth during their maturing years, which aligns with declines of Chinook Salmon returns in the 1990s, and the decline in size and proportion of Chinook Salmon in more recent decades (Groskreutz et al. 2019). • In 2019, Ocean Wise photographed 55 NRKW off the central coast of BC, and then expanded their research efforts to northeast Vancouver Island where photographed 66 NRKW (Barrett-Lennard pers. comm. 2020). Results on body condition of SRKW from photogrammetry data collected between 2015 and 2017 are reported in Fearnbach et al. (2020). Ocean Wise received funding from DFO to conduct this work over the time period of this report. • Using fecal samples from SRKW, researchers were able to measure thyroid and glucocorticoid hormone metabolites to assess how pregnancy success between 2008 and 2014 was impacted by nutritional and other stressors (Wasser et al. 2017). Up to 69% of all detectable pregnancies were unsuccessful. Low availability of Chinook Salmon appears to be an important stressor		

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		and significant cause of late pregnancy failure. Additionally, the release of toxicants during fat metabolism in the nutritionally deprived animals may also contribute to these cumulative effects (Wasser et al. 2017).		
Extensive sampling of populations to establish baseline contaminant levels	Monitor pollutants, diseases, pathogens, parasites and pathologies in Killer Whales	• Biopsy samples collected from RKW are being analyzed for PCBs, PBDEs, fatty acids, and stable isotopes (Noel pers. comm. 2020). • RKW samples from 2015 and adult chinook samples from 2014 and 2018 were compiled to characterize the risk of emerging brominated and chlorinated flame retardants in RKWs relative to legacy PCBs and PBDEs risks (DFO unpublished data; Brown pers. comm. 2020). • Fecal samples collected from SRKW between 2010 to 2013 were analyzed for polycyclic aromatic hydrocarbon (PAHs) concentrations, a common component of oil as well as a combustion product from vessel motors (Lundin et al. 2018). Overall PAH concentrations were low (<10 ppb) however were elevated prior to guidelines mandating increased distance between vessels and whales implemented in 2010 (Lundin et al. 2018). • Exhaled breath samples of SRKW have been analyzed to identify normal microbial flora as well as pathologies in the respiratory tracts (Raverty et al. 2017).	Objective 2: ensure that chemical and biological pollutants do not prevent the recovery of Resident Killer Whale populations.	Academia, DFO, Ocean Wise
Completed analyses of contaminants in Killer Whale samples	Monitor pollutants, diseases, pathogens, parasites and pathologies in Killer Whales	• Desforges et al. (2018) report on PCB concentrations in Killer Whales from populations around the world and Alava et al. (2016) report on calculated and observed PBDE concentrations in NRKW and SRKW. • Results from samples collected from RKW from 1993 to 2009 in the Salish Sea and samples of SRKW collected in 2015 by NOAA scientists were compiled (Guy 2018). The average for total PCB concentration for NRKW adult males was 10.09 mg/kg lipid weight (standard deviation +/- 2.37 mg/kg) and the average for total PCB concentration for NRKW adult females was 4.97 mg/kg lipid	Objective 2: ensure that chemical and biological pollutants do not prevent the recovery of Resident Killer Whale populations.	**Academia**

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		weight (standard deviation +/- 2.85 mg/kg). Analysis indicated that there was a statistically significant decline in the total PCB concentrations in adult NRKW males but not in adult NRKW females (Pearce and Gobas 2018 unpublished; Guy 2018). • The same study found that the average total PCB concentration for SRKW adult males was 40.74 mg/kg lipid weight (standard deviation +/- 2.89 mg/kg) and the average total PCB concentration for SRKW adult females was 17.46 mg/kg lipid weight (standard deviation +/- 3.20 mg/kg) for all samples collected from 1996 to 2015 (Pearce and Gobas 2018 unpublished). Analysis indicated that there was not a statistically significant decline in the total PCB concentration in either adult SRKW males or females over this time period (Pearce and Gobas 2018 unpublished; Pearce 2018).[6] • Using a total of 263 fecal samples collected from 54 SRKW between 2010 to 2013, Lundin et al. (2016) reported that concentrations of Persistent Organic Pollutants (POPs) were highest when prey abundance was lowest, likely because toxins were released from endogenous lipid stores when these stores are metabolized during prey shortages.		
Completed necropsies of stranded Killer Whales	Monitor pollutants, diseases, pathogens, parasites and pathologies in Killer Whales[7]	• DFO's Marine Mammal Response Program responds to reports of stranded Killer Whales with assistance from marine mammal partner groups for BC Killer Whales (Government of Canada 2020c). Nine necropsies were conducted on stranded Killer Whales in BC between 2015 and 2019; three confirmed on SRKW and one confirmed on NRKW (Cottrell pers. comm. 2020). PCA supports necropsy efforts when stranded whales are located within park reserves (Kroeker pers. comm. 2021).	Objective 2: ensure that chemical and biological pollutants do not prevent the recovery of Resident Killer Whale populations.	**DFO, BC MoAFF, NOAA,** PCA

[6] These results must be viewed in the context of the data limitations and small sample sizes. The PCB concentration accumulated by Killer Whales depends on many other factors such as their age, dietary preference, calving order, reproductive history, birth year, pod membership, and life history that could not be assessed in this study.
[7] New research indicates that Killer Whales are highly vulnerable to infectious disease (such as cetacean morbillivirus) outbreaks because of their strong social networks (Weiss et al. 2020).

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		• An analysis of Killer Whale necropsies from 2004 to 2013 in the North Pacific Ocean was completed. Causes of calf mortalities included infectious disease, nutritional, and congenital malformations. Mortalities in sub-adults were due to trauma, malnutrition, and infectious disease and in adults due to bacterial infections, emaciation and blunt force trauma. Death related to human interaction was found in every age class (Raverty et al. 2020).		
Completed sampling and analyses of contaminants in Killer Whale prey	Identify and prioritize key chemical and biological pollutants	• Over 2,000 muscle samples from harvested Chinook Salmon have been collected from BC coastal waters. Stable isotope analyses are being analyzed on all samples. Contaminant analyses will be done on the Chinook stocks most commonly eaten by SRKW and NRKW to evaluate differences in contaminant concentrations and profiles across the various stocks. Contaminant analyses are also being done on other important RKW food web species, including: Chum, Coho, Black Cod, Herring and Sand lance. This will enable a risk assessment and ranking of contaminant classes for both adult Chinook and RKW (Brown pers. comm. 2020). • Samples (liver or whole fish) from juvenile Chinook Salmon were collected from four sites along the Fraser River and one reference site in Cowichan Bay. Five composites of whole fish in 2019 were analyzed for over 400 contaminants to identify which contaminants represent the greatest health risk for juvenile Chinook. Results indicated that the number of pharmaceuticals and personal care products detected in water and fish tissue decrease with increasing distance from wastewater treatment plants and urban areas. Some compounds in juvenile Chinook and water are at similar levels where adverse health effects have been reported in juvenile salmon (Brown pers. comm. 2020). • The Washington Department of Fish Wildlife tested Chinook Salmon from Puget Sound basins for POPs in 2016 and 2017. Contaminant concentrations varied by marine basin, with higher concentrations in fish caught in South Puget Sound and	Objective 2: ensure that chemical and biological pollutants do not prevent the recovery of Resident Killer Whale populations.	**DFO,** ECCC, Washington Department of Fish and Wildlife, US Geological Survey

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		progressively decreasing levels moving north through the Strait of Juan de Fuca. Concentrations for PCB's exceeded the Washington Department of Health's PCB screening value for human health (23 ng/g) in all locations, while PBDEs and Dichlorodiphenyltrichloroethane (DDT) concentrations were well below human health screening values (O'Neill et al. as reported in the Puget Sound Ecosystem Monitoring Program [PSEMP] Toxics Group 2019). • Sand lance (forage fish that are prey to salmon) collected in Puget Sound were analyzed for more than 200 urban contaminants including PCBs. All egg samples contained PCBs and larger individuals had higher concentrations than smaller fish, providing evidence of bioaccumulation (Liedtke et al. as reported in PSEMP Toxics Work Group 2019). • Pacific Rim National Park Reserve and Gulf Islands National Park Reserve are currently supporting contaminants analyses on Pacific Sand Lance from the Salish Sea and West Coast of Vancouver Island as part of a collaborative research program between DFO, Environment and Climate Change Canada (ECCC) and PCA. Laboratory results will be available in 2021 (Kroeker pers. comm. 2021).		
Water quality sampling in areas throughout range of Resident Killer Whales	Identify and prioritize key sources of chemical and biological pollutants	• The Boundary Bay Ambient Monitoring Program (BBAMP) is one of four ambient monitoring programs conducted by Metro Vancouver Regional District. After a five-year cycle, the program underwent a review in 2016 and 2017 on data generated between 2009 and 2015. They analyzed marine water quality, sediment, and biota for various parameters and contaminants in relation to BC Ministry of Environment and Climate Change Strategy	Objective 2: ensure that chemical and biological pollutants do not prevent the recovery of Resident Killer Whale populations.	BC Ministry of Environment and Climate Change Strategy, ECCC, Metro Vancouver, Tsleil-Waututh Nation

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		objectives and guidelines. For an overview of the results, see Hightower (as reported in PSEMP Toxics Work Group 2019).[8] • The BC Ministry of Environment and Climate Change Strategy and Tsleil-Waututh Nation established the Burrard Inlet Water Quality Objectives in 1990 to inform water quality management and protect the water values associated with the marine waters of Burrard Inlet and its freshwater tributaries (British Columbia Ministry of Environment and Climate Change Strategy and Tsleil-Waututh Nation 2020).[9] • Monitoring activities are conducted to help manage risk from toxic chemicals. Under the 2018 to 2023 Whales Initiative (Government of Canada 2018d), ECCC's science efforts focus on identifying key sources of contaminants and how they are entering aquatic environments, so that we will be in a better position to manage them. These efforts include: ○ wastewater monitoring to measure contaminant concentrations in effluent entering the Salish Sea ○ air monitoring to measure contaminant transport and deposition from distant and local sources such as urban areas to habitat for Killer Whales and their prey ○ freshwater (monthly) and sediment (annual) sampling within the Fraser River watershed to identify presence of contaminants that may impact SRKW and/or their prey and to assist with the characterization of contaminant exposure to juvenile chinook (Environment and Climate Change Canada 2021) ○ landfill leachate sampling of contaminants of concern at ten municipal solid waste landfill sites in Canada (located in or near the critical or living habitats of three endangered whale		

[8] In 2020, Metro Vancouver initiated a detailed review and synthesis of all regional and municipal monitoring work performed between 2013 and 2017 under BBAMP with an emphasis on identifying and assessing any potential ecological and human health effects from Metro Vancouver discharges within Boundary Bay (Knezevic-Stevanovic pers. comm. 2020).
[9] The Burrard Inlet Water Quality Objectives were most recently updated in 2020.

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		species, including SRKW) to confirm whether specific contaminants are being released from landfills in concentrations and loadings that would pose a risk ○ increased sediment sampling at disposal at sea locations and the surrounding ambient environment to monitor for priority contaminants that may impact Killer Whales, and levels of emerging contaminants of concern for future trend assessments		
Measurable decline in contaminant levels in environment (prey, sediments, etc.)	Reduce introduction of chemical pollutants into environment	• PollutionTracker, a long-term, coast-wide monitoring program for contaminants in sediments and mussels, was launched by Ocean Wise in 2015. The PollutionTracker website provides project information and Phase 1 summary results (2015 to 2017) (Ocean Wise Conservation Association 2019). Phase 2 sample collection is complete and analysis is being completed (Noel pers. comm. 2020); Phase 2 will lay the foundation for a coast-wide temporal trend analysis. PCA and the Council of the Haida Nation have collaborated with PollutionTracker to collect sediment samples from Gwaii Haanas and Haida Gwaii respectively (Lee pers. comm. 2020). • Sediment samples were collected and analyzed for PCBs as part of several monitoring and research programs in the southern Strait of Georgia and SRKW critical habitat over the past few decades. The results were compiled as part of recent graduate research out of Simon Fraser University. Analysis indicated that the concentration of total PCBs in sediment in the Salish Sea did not decline substantially in the 15 year period from 2002 to 2017, suggesting an ongoing regional input of PCBs into the Salish Sea environment (Pearce 2018). PCB concentrations in Chinook salmon collected in 2000 and 2014 also did not show a statistically significant difference, however these results should be interpreted with caution of a low sample size and only two monitoring years (Pearce 2018). • Concentrations of POPs were measured in sediment samples from 12 sites near urban areas in the Salish Sea. Despite the	Objective 2: ensure that chemical and biological pollutants do not prevent the recovery of Resident Killer Whale populations.	Academia, ECCC, NOAA, Ocean Wise, Indigenous groups, PCA, PSEMP, Washington State Department of Ecology

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		implementation of regulations for PCBs and PBDEs, both persisted in sediment samples. Victoria Harbour and East Terminal in Burrard Inlet were the most contaminated sites in the Canadian portion of the Salish Sea. These measurements allow for future analysis of trends in contaminants over space and time (Morales-Caselles et al. 2017). • NOAA's National Status and Trends Program has been monitoring PCBs and other contaminants in mussels and oysters along the US coastline since 1986, including sites along the Washington coast. Data for specific geographic locations is publicly accessible (NCCOS 2020). • The PSEMP's Toxics Work Group meets bi-monthly and focuses on improving toxics related monitoring by encouraging coordination and collaboration, identifying priorities and gaps, and increasing knowledge and understanding. A synthesis of recent toxic monitoring research in the Salish Sea is reported on in the 2018 Salish Sea Toxics Monitoring Synthesis (PSEMP Toxics Work Group 2019). • The Washington State Department of Ecology conducts long-term monitoring of marine sediment in Puget Sound. Sediment condition is evaluated annually for toxic chemical concentrations. After 28 years, monitoring has indicated that toxic contaminants are generally in concentrations below regulatory thresholds in most locations (PSEMP Toxics Work Group 2019). • West et al. (2017) modeled temporal trends in PCBs, PBDEs, and DDTs in English Sole and Pacific Herring in Puget Sound, Washington over a 16 to 21 year period. They found declines in PBDEs and DDTs overall, but a persistence of PCBs in these indicator fish despite bans in PCB production and use (West et al. 2017).		

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
Evaluation of effectiveness of legislation completed	Mitigate impacts of currently used pollutants	• In December 2018, the Government of Canada published a consultation document proposing to strengthen the regulatory controls for PBDEs and four other POPs that are listed as toxic under section 64 of the *Canadian Environmental Protection Act*, 1999 (CEPA) (Government of Canada 1999, 2018a). The consultation document proposed to strengthen the regulatory controls by amending the *Prohibition of Certain Toxic Substances Regulations, 2012* (PCTSR) to remove existing exemptions, or provide time limits on the exemptions, such that the substances are phased out of use. Additionally, the consultation document proposes to add two substances (dechlorane plus and decabromodiphenyl ethane, which were recently found to be toxic under section 64 of CEPA) to the PCTSR. The proposed addition of the two substances to the PCTSR would prohibit the manufacture, import, use and sale of these substances and products that contain them. The Proposed Regulations amending the PCTSR are targeted for publication in 2021. • Mercury, PAH, and lead have all been identified as contaminants of concern to RKW and their prey. The Government of Canada has implemented several measures to reduce emissions of these contaminants. For mercury, a number of actions have been taken since the publication of the Risk Management Strategy for Mercury (Government of Canada 2010) including: Products Containing Mercury Regulations (Government of Canada 2014), addition of mercury to the Export of Substances on the Export Control List Regulations in 2017 (Government of Canada 2018b), Code of Practice for the Environmentally Sound Management of End-of-Life Mercury Lamps (Environment and Climate Change Canada 2017), and the National Strategy for the Safe and Ecological Disposal of Lamps Containing Mercury (Environment and Climate Change Canada 2019). Internationally, the Government of Canada has been working with other countries to reduce exposure to contaminants from foreign sources over time. This includes efforts under the Minamata Convention on Mercury, which aims to protect human health and the environment from the adverse effects of mercury through obligations to control and	Objective 2: ensure that chemical and biological pollutants do not prevent the recovery of Resident Killer Whale populations.	**Government of Canada**, CCG, DFO, Northwest Area Contingency Plan Partners

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		reduce anthropogenic emissions of mercury throughout the mercury life cycle (UN environment programme 2021). • Since the publication of the Risk Management Strategy for Lead (Government of Canada 2013), the Government of Canada has commissioned studies to gather information the use of lead and lead-free alternatives in Canadian industries and for certain recreational activities (for example, hunting and fishing) (Pilon pers. comm. 2021; references available upon request). The use of lead sinkers and jigs for fishing is prohibited in National Parks and National Wildlife Areas pursuant to recent amendments to regulations under the *Canada Wildlife Act* (Justice Canada 2018d; Justice Canada 2020). • According to the 2019 Air Pollutant Emission Inventory (Government of Canada 2020a) during the last decade, lead emissions in Canada declined by 28% and those of mercury by 61%. During the same period, according to the National Pollutant Release Inventory, quantities of lead and mercury released into the water declined by 44% and 66%, respectively (Government of Canada 2021).[10] • The Northwest Area Contingency Plan includes a Wildlife Response Plan which describes deterrence and monitoring options for Killer Whales in the event of an oil spill (Regional Response Team 10 and the Northwest Area Committee 2019). • DFO's response planning effort supports Area Response Plans as led by the Canadian Coast Guard (CCG). This support includes the DFO Pacific Region Marine Mammal Rescue Team leading the operational on-water spill response preventive mitigation measures for Killer Whales. Investments in equipment and training		

[10] Reports examining these results in greater detail and evaluating the effectiveness of risk management measures for lead and mercury were published in 2020 as part of the Government of Canada's commitment to performance measurement evaluation (Government of Canada 2020b, 2020d) .

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		have been made that increase DFO's overall marine mammal response capacity, capabilities, and preparedness. Protection of *Species at Risk Act* (SARA) listed species is prioritized when supporting response measures during a spill scenario (Chiang pers. comm. 2020).		
PCB sources identified	Mitigate impacts of 'legacy' pollutants	• The Government of Canada's Chemicals Management Plan (CMP), which has been in place since 2006, aims to reduce the risks posed by chemicals to Canadians and the environment. The CMP builds on previous initiatives by assessing chemicals used in Canada and by taking action on chemicals found to be harmful to human health and/or the environment. Since 2008, the Government of Canada has PCB Regulations that are meant to prevent the release of PCBs to the environment and accelerate the phasing out of PCB-containing equipment at specified concentrations (Government of Canada 2015a). • The State of Washington Department of Ecology completed an analysis of the presence of PCBs in general consumer products and the potential release of PCBs into the environment. They concluded that PCBs are found in consumer products and can enter the environment in significant concentrations through water and air discharges (Stone 2014). • Under the 2018 to 2023 Whales Initiative, an ECCC-led Contaminants Technical Working Group was formed. Twenty seven contaminants were examined with an additional three contaminant classes to form a list of priority contaminants of concern for SRKW. PCBs were identified as a priority contaminant of concern (Environment and Climate Change Canada 2020). Stemming from one of the mandates of the ECCC-led Contaminants Technical Working Group, an inventory tool was developed to identify point and non-point sources of contaminants affecting SRKW and their prey. As part of the inventory, sites where PCBs are still in use or stored in Killer Whale habitat were identified (Environment and Climate Change Canada 2020).	Objective 2: ensure that chemical and biological pollutants do not prevent the recovery of Resident Killer Whale populations.	**Academia, ECCC, Government of Canada,** Washington State Department of Ecology

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
Evaluation of effectiveness of legislation completed	Reduce introduction of biological pollutants	• The federal Wastewater Systems Effluent Regulations (SOR/2012-139) reduce threats to fish and fish habitat by setting out national effluent quality standards for wastewater systems that collect 100 m^3 per day or more (Government of Canada 2015b). Owners of wastewater systems that are not designed to meet the prescribed limits must upgrade to achieve at least a secondary level of treatment, which is able to remove approximately 95% of conventional contaminants and 90% of some pollutants such as PBDEs. The Government of Canada is providing funding for wastewater treatment plant upgrades in BC through the Investing in Canada long-term infrastructure plan (Government of Canada 2017). • The Government of Canada is providing up to $211 million for infrastructure upgrades to the wastewater facility in the Capital Regional District including Victoria. The new McLoughlin Point Wastewater Treatment Plant is expected to achieve a tertiary level of treatment (involves a series of additional steps after secondary treatment to further reduce organics, turbidity, nitrogen, phosphorus, metals, and pathogens). The Government of Canada will also be providing up to $212 million to construct a new plant to replace the Lions Gate wastewater treatment plant in Metro Vancouver. The new North Shore wastewater treatment plant is expected to achieve a tertiary level of treatment (Pilon pers. comm. 2020). • The Washington State Department of Ecology initiated a Stormwater Action Monitoring program to characterize the contaminants in nearshore sediment adjacent to urban growth areas. In 2016, a total of 41 sites were sampled and results showed that concentrations of metals and organics in nearshore sediment adjacent to urban growth areas are generally low (Black et al. in PSEMP Toxics Work Group 2019). The results of this study will help the State of Washington Department of Ecology refine municipal stormwater permit requirements as well as help other agencies develop nearshore and marine monitoring and restoration programs (PSEMP Toxics Work Group 2019).	Objective 2: ensure that chemical and biological pollutants do not prevent the recovery of Resident Killer Whale populations.	**Government of Canada,** Washington State Department of Ecology

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
Controlled studies of whale/boat interactions completed	Investigate short-term effects of chronic forms of disturbance	• Commercial and recreational vessel compliance with mandatory viewing distances was examined across two seasons (June to September 2018 and 2019) in the Salish Sea. Overall compliance was approximately 80%, although recreational boaters were significantly more likely violate distance regulations then commercial vessels and boaters were more likely to be non-compliant around Killer Whales than Humpback Whales (Fraser et al. 2020). • The frequency and severity of injuries from ship strikes on RKW is uncertain (Murray et al. 2019). Over the time period of this report (2015 to 2019), there were four known incidents of vessel strikes causing injury to NRKW; they are reported on in Murray et al. (2019). • An analysis of Killer Whale necropsies over the time period of 2006 and 2013 identified vessel strike-related trauma as a significant cause of morbidity or mortality in Killer Whales, particularly in the SRKW population that frequents areas near large human populations and shipping lanes (Raverty et al. 2020). • Bio-logging tags were temporally attached to SRKW individuals in 2010, 2012, and 2014 to more fully understand their subsurface behavior and to investigate vessel effects on behaviour, including foraging behaviour involving prey capture. Analysis results suggest that whales made fewer dives involving prey capture and spent less time in these dives when vessels had an average distance less than 400 yards (366 m) and that female SRKW were more likely to transition to a non-foraging state when vessels had an average distance less than 400 yards (366 m) (Holt et al. 2021). • Data on vessels and whales near Robson Bight Michael Bigg Ecological Reserve were collected by DFO starting in 2018	Objective 3: ensure that disturbance from human activities does not prevent the recovery of Resident Killer Whales	Academia, Cetus Research and Conservation Society, DFO, US National Marine Fisheries Service

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		(Thornton pers. comm. 2020).[11] • The Straitwatch Program, operated by Cetus Research and Conservation Society, continues to monitor marine vessel and Killer Whale interactions and record and report harassment and non-compliance incidents in the waters around Vancouver Island. Specific to the waters in and around Robson Bight Ecological Reserve, the Robson Bight Marine Warden program patrols the perimeter of the reserve and ensures that no boats enter it (Cetus Research and Conservation Society 2019). • A literature review was conducted to determine relevant sources of disturbance and associated behavioral responses for several Odontocete species (Bottlenose Dolphin, Killer Whale, Harbor Porpoise, and Beaked Whales). Researchers found that Odontocetes may increase their energy expenditures in response to acoustic disturbance, but short-lived responses with relatively small metabolic costs (for example, tail slaps, vocal compensation, and moderate changes in swim speed) are relatively low. However, time spent foraging can be significantly reduced in the presence of vessels and is likely to have the larger impact on individuals in terms of a reduction in energy acquisition (Noren et al. 2016). • Vessel surveys for SRKW (presence) and behavioural assessments categorizing SRKW activity state were conducted starting in 2018. The study focuses on Swiftsure Bank and Juan de Fuca Strait, and the June to August timing coincides with the three Fraser River salmon runs (Thornton pers. comm. 2020).		
Complete controlled study of marine	Investigate short-term effects of	• Controlled studies on the impact of seismic operations on marine mammals has not been conducted in Canada.	Objective 3: ensure that disturbance from human	**DFO**

[11] Shore-cabled passive acoustic monitoring (PAM) stations were successfully deployed near three rubbing beaches in 2020 (Thornton pers. comm. 2020). The acoustic recorders are being used to record the influence of noise and distance of vessels on NRKW rubbing beach use, acoustic environment, and vocal behaviour of whales (Thornton pers. comm. 2020).

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
mammals in areas where seismic exploration is active	acute forms of disturbance, and long-term effects of acute forms of disturbance	• In 2015, DFO undertook a study to determine if the mitigation measures outlined in the 2007 Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP) are likely to avoid SARA prohibited impacts on listed cetaceans, to identify potential gaps or issues, and to provide additional or modified mitigation measures that should be considered to further reduce potential impacts (Moors-Murphy and Theriault 2017). A National Peer Review meeting took place in 2019 to undertake a comprehensive review of the effectiveness of the SOCP in protecting marine species. The intent of this process was to develop science advice that is applicable at the national level to be used to review and potentially update the mitigation measures in the SOCP (DFO 2019e).[12]	activities does not prevent the recovery of Resident Killer Whales	
Complete model that incorporates effects of increasing ambient noise levels on communication signals of Resident Killer Whales	Investigate long-term effects of chronic forms of disturbance	• In 2018 and 2019, DFO deployed 24 digital acoustic recording tags (DTAGs) on NRKW to assess diel behaviour and foraging efficiency, vocalizations, and received sound levels. This study is designed to assess night time behaviour and data collected will also form part of a collaborative study with NOAA to compare SRKW and NRKW diel cycles (Thornton pers. comm. 2020). Since 2018, NOAA has deployed 10 DTAGs on SRKW to support this comparison between populations (Thornton pers. comm. 2020). Data collected from DTAGs during foraging events help to identify acoustic cues associated with all stages of foraging, enabling further investigations into the effects of vessel and noise disturbance on foraging outcomes (Tennessen et al. 2019). • The Vancouver Fraser Port Authority-led ECHO Program was convened in 2014 and involves the transboundary collaboration of marine transportation industries (representing ships, ferries, tugs), conservation groups, scientists, academic and technical consultants, Indigenous groups and Canadian and US governments, including representatives from DFO, Transport	Objective 3: ensure that disturbance from human activities does not prevent the recovery of Resident Killer Whales	DFO, NOAA, Vancouver Fraser Port Authority-led ECHO program (membership included in activity description)

[12] Based on new scientific information and industry best practices, the scientific review concluded that there is sufficient new information to support an update to the measures in the SOCP. The review contains potential modifications and additions to the SOCP that should be considered (DFO 2020c).

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		Canada (TC), NOAA, and Canadian and US Coast Guards. The ECHO Program commissioned a study to better understand the effects of underwater noise from whale watching boats and commercial vessels on SRKW in the Salish Sea. Based on a computer simulation model, study results estimated that the relative contribution of noise from whale watching boats and commercial vessels to cumulative vessel noise effects on SRKW totaled a loss of foraging time representing 20 to 23% (4.9 to 5.5 hours) of each day that SRKW are present in the study area during May to September. Approximately two thirds of time loss is due to noise from large commercial vessels and one third is due to noise from whale watching boats (SMRU Consulting North America 2017). • A peer reviewed modeling study evaluating the benefit of the 2017 ECHO Program Haro Strait voluntary vessel slowdown on SRKW predicted that underwater noise reductions associated with the slowdown trial achieved a 22% reduction in 'potential lost foraging time' for SRKW (Joy et al. 2019). More details on the voluntary slowdown trial are reported on below under the following performance measure: "Establishment of underwater vessel noise reduction measures".		
Complete acoustic profiles of vessels most likely to be encountered by Resident Killer Whales	Determine baseline ambient and anthropogenic noise profiles	• DFO conducted a review to evaluate the scientific evidence related to mitigation measures that could be applied to reduce shipping-related noise within SRKW critical habitat (DFO 2017b). Noise emitted from ships varies with factors such as speed, loading, draft, engine type, propulsion system, and vessel type, and can vary substantially among individual vessels of the same vessel class (for example, bulk freighters, container ships, tankers) (Simard et al. 2016). DFO (2018d) provides advice on the potential effectiveness of mitigation measures and provides information or knowledge concerning the relationship between a vessel's speed and tonnage and how much underwater noise the vessel creates.	Objective 3: ensure that disturbance from human activities does not prevent the recovery of Resident Killer Whales	Academia, BC Ferries, DFO, JASCO Applied Sciences, NOAA, NRC Ocean Networks Canada, PCA, TC, Vancouver Fraser Port Authority-led ECHO Program

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		• Building off of the work above by DFO, TC has taken further actions to understand vessel noise in order to reduce disturbance to SRKW. TC's work to date to increase understanding of underwater soundscapes includes: • Green Marine Management Corporation's report "Understanding Anthropogenic Underwater Noise", commissioned by TC consolidates technical knowledge about anthropogenic underwater noise and its impacts on the marine environment. It includes information about how, based on the current state of knowledge, the maritime industry contributes to ambient underwater noise. The report also discusses how underwater noise impacts conservation efforts for marine animals, including the recovery of species at risk (Green Marine Management Corporation 2017) • report entitled "Assessment of Vessel Noise within Southern Resident Killer Whales Critical Habitat" assesses the effectiveness of mitigation strategies designed to reduce exposure of vessel noise to marine fauna in the southern Salish Sea. Noise mitigation strategies assessed include slowing vessels, restricting traffic during certain times of the day, rerouting traffic, and convoying commercial vessels (JASCO Applied Sciences 2018) • report entitled "Simulation Manoeuvring Analysis – Vessel Low Speed Transits in Areas Identified as Whale Sensitive Habitat" includes an analysis of minimum safe transit speeds that can be adhered to by various vessel types, with special consideration to the unique physical, weather, and prevailing navigational conditions in four known areas of concern for whale populations, including SRKW (LANTEC Marine 2019) • report entitled "Ship Underwater Radiated Noise" reviews means of mitigating and predicting the underwater radiated noise from vessels (VARD Marine Inc. 2019) • ongoing project with the National Research Council Canada (NRC) to understand propeller-induced hull vibration and noise (Sanders pers. comm. 2020)		

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		• ongoing project entitled “Propeller Tolerance Study” to analyze whether propeller manufacturing tolerances can be improved to reduce underwater noise (Sanders pers. comm. 2020) • Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve and Haida Heritage Site, in collaboration with DFO, has been collecting baseline ocean noise data from an autonomous deepwater hydrophone off the west coast of Gwaii Haanas off Gowgaia Bay annually since summer 2017, and from an autonomous hydrophone off the east coast in Juan Perez Sound since summer 2018. Unfortunately, the Juan Perez Sound hydrophone did not record data from summer 2019 and 2020. Data from these hydrophone is being analyzed with JASCO Applied Sciences, in collaboration with BC ocean noise experts from multiple agencies, ENGOs, and academia to determine baselines and potential metrics for monitoring ocean noise conditions in Gwaii Haanas (Lee pers. comm. 2021). • With financial support from Government of Canada, Ocean Wise convened a workshop with the goal of characterizing underwater noise that negatively impact SRKW. The workshop participants agreed the range of impacts should be captured in 3 metrics: (1) noise-induced changes in behaviour, physiology, and/or health, (2) communication masking, and (3) echolocation masking (Heise et al. 2017). • In partnership with TC, DFO, Ocean Networks Canada, and JASCO Applied Sciences, the ECHO Program installed an underwater listening station in the Strait of Georgia in 2015 to monitor underwater noise source levels from large commercial vessels (deep-sea ships, ferries, tugs), as well as marine mammal presence and total ambient underwater noise. The underwater listening station operated for over two and a half years and was successful in providing near real-time analysis of vessel source levels for over 5,100 vessel transits (Ocean Networks Canada 2018).		

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		• The ECHO Program advanced a regional ocean noise contributors study to evaluate how much underwater noise comes from different commercial vessel sectors (for example, deep-sea ships, ferries, tugs) and how much comes from recreational, fishing, and whale watching sectors throughout the year (MacGillivray et al. 2016). In 2017, the ECHO Program and DFO supported a small boat underwater noise measurement study in Haro Strait to better understand the underwater noise levels of whale watching and other small boats that operate in the Salish Sea near important summer feeding areas for SRKW (Wladichuk et al. 2019). Results from this study can be incorporated into models to predict sound levels received by SRKW. • To evaluate changes in ambient underwater noise over time or with the implementation of specific underwater noise reduction measures, the ECHO Program acknowledged that it is important to understand how to consider and account for factors such as large ship and small boat traffic, currents, water temperature, weather, and biological components. In 2019, the ECHO Program completed an ambient underwater noise evaluation study which identified and evaluated the key factors affecting ambient noise at three hydrophone locations in the Salish Sea monitored by the ECHO Program in 2016 and 2017 (Warner et al. 2019). • Between 2015 and 2017, BC Ferries conducted noise measures of their vessels and in 2018, underwater radiated noise targets were incorporated into the BC Ferries Fleet Master Plan and into new vessel construction contracts. In 2019, BC Ferries released a Long Term Underwater Radiated Noise Mitigation Plan. On going work is focused on supporting a noise control program for all new construction and retrofitting projects on existing vessels (BC Ferries 2019). • Since 2018, DFO has had several Passive Acoustic Monitoring (PAM) devices deployed in the Salish Sea in key SRKW habitats that are adjacent to or in the proximity of shipping lanes. The recorders are used to collect baseline ambient noise data 24/7		

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		that allows for a full understanding of the acoustic profile of the area and factors causing variation in noise levels. The collected data in 2018 and 2019 allowed for the investigation of the voluntary lateral vessel displacement trials (Vagle and Neves 2019; Vagle 2020). • The Noise Exposure to Marine Ecosystems from Ships project, lead out of the University of Victoria, is assessing ambient noise and existing vessel traffic in the Salish Sea (DFO 2017d). This will serve as a baseline for future comparisons pending increased shipping. • Researchers at University of Victoria and ECCC have developed an autonomous and integrated optical camera and Automatic Identification System (AIS) for identifying and quantifying both AIS and non-AIS broadcasting vessels transiting in Boundary Pass, Haro Strait, and Active Pass. As well, they are currently working on developing methodology and collecting imagery data with TC's National Aerial Surveillance Program that conducts regular surveys throughout the Salish Sea year-round. This project will help determine the quantity, behaviour, and composition of the non-AIS vessel fleet utilizing key foraging areas for SRKW within the Salish Sea (O'Hara pers. comm. 2020; McWhinnie et al. 2021). This project received funding by DFO to conduct this work over the time period of this report. • Veirs et al. (2016) used a combination of calibrated hydrophone measurements and vessel location data from the AIS to provide modelled estimates of sound source pressure levels for 1,582 unique ships that transited Haro Strait (SRKW critical habitat) between March 2011 and October 2013. Analysis revealed that half of the total power radiated by a modern fleet comes from just 15% of the ships (Veirs et al. 2018). • Houghton et al. (2015) attached DTAGs to SRKW to measure noise levels received from all vessels within 1000 m of the tagged whale. They found that vessel speed was the most important		

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		predictor of noise levels received by whales in this study (Houghton et al. 2015). Holt et al. (2017) later reported that noise measured from DTAGs on SRKW was best predicted by animal ID, vessel count, vessel speed category, and year. The main difference between the two studies was that Holt et al. (2017) only considered vessels within a shorter 400 m radius of the tagged whale for which a direct path of the sound from ship to whale provides an appropriate measure of the totally received noise contribution from that vessel. At distances greater than 400 m, surface and sea bottom interactions of the radiated sound make it more difficult to assess noise contributions of individual vessels. • Cominelli et al. (2018) assessed the vessel noise exposure levels for SRKW in the Salish Sea in areas delineated as SRKW summer core areas. Statistical models were used to evaluate SRKW's noise exposure from 15 vessel categories. Ferries, tugboats, vehicle carriers, recreational vessels, containers, and bulkers produced high levels of noise exposure within SRKW core areas.		
Revised whale watching guidelines, and/ or regulations that reflect most recent understanding of effects of chronic physical disturbance	Develop measures to reduce physical disturbance	• The 2018 amendments to the *Marine Mammal Regulations* under the *Fisheries Act* include the introduction of a general minimum approach distance of 200 m for all Killer Whales found in Canadian fisheries waters in the Pacific Ocean (Justice Canada 2018c). • In 2019, four additional fishery officers were hired to form a Whale Protection Unit, an initiative funded by the 2018 to 2023 Whales Initiative (Cauffopé pers. comm. 2019). Fishery officers verify compliance with fisheries management measures, updated *Marine Mammal Regulations*, and will enforce the disturbance and harassment provisions of the regulations and SARA. • The ongoing maintenance of the 24 hour Observe Record Report Line for the reporting of acoustic or physical disturbance incidents ensures timely response and enforcement of whale watching guidelines. Between 2015 and 2019, there were an average of 68 Killer Whale disturbance reports annually, ranging from 21 in	Objective 3: ensure that disturbance from human activities does not prevent the recovery of Resident Killer Whales	**DFO,** ENGOs, Indigenous Groups, Industry, NOAA, PCA, TC, Washington State, WDFW

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		2016 and 136 in 2019 (Cottrell et al. in prep). It is important to note that identification at the population level is often unknown and not all sightings or disturbance incidents can be confirmed. It is unknown whether the increase in reports in 2019 was a result of an increase in incidents of non-compliance, or increased awareness of the reporting hotline. • PCA wardens and field staff monitor and report on activities in marine waters within and adjacent to park reserve waters and national marine conservation areas to ensure that regulations are followed (Lee pers. comm. 2020). • The BWW guidelines are reviewed and updated as necessary by the BWW Working Group and the website is frequently updated to reflect the most recent marine mammal regulations and information on how to report violators in both US and Canadian waters (Cottrell pers. comm. 2019). • In addition to the BWW guidelines, the North Island Marine Mammal Stewardship Association have developed a regionally specific code of conduct to ensure the health of marine wildlife off northern Vancouver Island (North Island Marine Mammal Stewardship Association 2019). • The Pacific Whale Watch Association (PWWA) have their own set of dynamic whale viewing guidelines (Pacific Whale Watch Association 2019). The PWWA last modified their voluntary guidelines in 2019 to reflect the latest regulations and voluntary measures. • In 2019, under the *Canada Shipping Act's* Interim Order, an approach distance of 400 m was in effect between June 1 and October 31 within SRKW critical habitat. Exceptions were made for authorized vessels (including commercial whale watchers) to be closer (up to 200 m) to Killer Whales that are not SRKW (DFO 2019a). The Interim Order was also put in place in subsequent years.		

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		• TC, the PWWA, and several independent ecotourism and whale watching companies entered an agreement to implement additional stewardship measures for 2019 in an effort to further reduce threats to SRKW. Under the agreement, the PWWA committed to refrain from offering tours on SRKW and to taking other stewardship actions, including respecting all voluntary measures to protect SRKW (Sanders pers. comm. 2020). • In 2011, NOAA published federal vessel regulations to prohibit vessels from approaching Killer Whales within 200 yards (182.9 m) and from parking in the path of the whales within 400 yards (365.8 m). To monitor the effectiveness of these regulations in achieving the goal of reducing vessel impacts on the whales, the US National Marine Fisheries Service published a review of the effectiveness of the 2011 vessel regulations using similar various measures including: education and outreach efforts, enforcement, vessel compliance, biological effectiveness, and economic impacts. For each measure, they focus on the five years leading up to the regulations (2006 to 2010) and compare trends and observations to the five years following the regulations (2011 to 2015) (Ferrara et al. 2017). • In 2019, Washington's Governor Jay Inslee signed into law new regulations governing whale watching in the State of Washington. US regulations require vessels to stay at least 300 yards away on either side of a SRKW's path and 400 yards out of the path, in front and behind the orcas (Washington State 2019). • In 2019, the Washington Legislature passed Senate Bill 5577: a bill concerning the protection of Southern Resident Orca Whales from vessels, which developed a license for commercial whale watching and directed the Washington Department of Fish and Wildlife (WDFW) to establish licensing processes and rules for licence holders' viewing of SRKW in order to reduce daily and		

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		cumulative impacts of whale watching on SRKW in US waters (Washington Department of Fish and Wildlife 2020)[13].		
Education and stewardship programs aimed at reducing vessel disturbance[14]	Develop measures to reduce physical disturbance	• DFO provides information about the BWW guidelines to stakeholders, the fishing industry, ENGOs working on the water, and members of the public. The guidelines also encourage the use of the "Whale Warning Flag" to warn fellow boaters to the presence of whales in the area (Be Whale Wise 2019). The use of the Whale Warning Flag is being expanded through the efforts of ENGOs and whale watch associations in both NRKW and SRKW critical habitat. • DFO's Habitat Stewardship Program (HSP) funds stewardship and outreach activities by various groups; the BC Cetacean Sightings Network, BC Ferries, Cetus, Haida Gwaii Marine Stewardship Group (a community-based partnership of federal agencies, ENGOs and Haida Gwaii communities led by the Council of the Haida Nation), Marine Education and Research Society , North Coast Cetacean Society (NCCS), and Saturna Island Marine Research and Education Society (SIMRES) all promote BWW guidelines and responsible vessel operation around marine mammals through presentations, signage, and other outreach materials. • The CCG launched a 'Marine Mammal Desk' co-located within the CCG's Marine Communications and Traffic Services Centre in Sidney, BC. The new Marine Mammal Desk will report whale sightings from sources such as CCG vessels, light stations, and aircraft operated by DFO, the CCG and TC in real time and advise vessel traffic of the activities of RKW. This information will be forwarded to on-water enforcement agencies to ensure the protection of the mammals as well as reported to the BC Cetacean Sightings Network. Planning for the Marine Mammal Desk begun	Objective 3: ensure that disturbance from human activities does not prevent the recovery of Resident Killer Whales	BC Ferries, DFO, ENGOs, Haida Gwaii Marine Stewardship Group, Indigenous Groups, Ocean Wise, PCA, Vancouver Fraser Port Authority-led ECHO Program

[13] Following a public comment period, the final rules were filed on December 23, 2020. For further detail, please reference WDFW (2021).
[14] Additional performance measure added for reporting purposes to offer a more comprehensive assessment of implementation of activities under the broad strategy: 'Develop measures to reduce physical disturbance'.

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		in 2019 although it was not fully operational until 2020 (Canadian Coast Guard 2021). • The Straitwatch Program and the Robson Bight Marine Warden program, operated by Cetus Research and Conservation Society, provide direct on-water education to vessel operators, and continue to record and report harassment and non-compliance incidents in the waters around Vancouver Island and around Robson Bight Ecological Reserve (Cetus Research and Conservation Society 2019). • The Coastal Guardian Watchmen Program is a territorial stewardship program comprised of Indigenous Groups along BC's north and central coast and Haida Gwaii. This nation-based guardian watchmen program monitors these coastal territories, including regular vessel-based patrols and educational presentations to ensure that regulations are followed (Coastal First Nations 2019). • In 2016, Ocean Wise's Coastal Oceans Research Institute, the Prince Rupert Port Authority, and the Vancouver Fraser Port Authority-led ECHO Program supported the development of the *Mariner's Guide to Whales, Dolphins, Porpoises of Western Canada* which helps mariners identify marine mammals, their seasonal usage of areas along the west coast, and ways to reduce potential interactions and physical disturbance from large commercial vessels (Ocean Wise Coastal Ocean Research Institute 2016). • In 2018, The WhaleReport Alert System mobile app was developed by Ocean Wise's BC Cetacean Sightings Network, in collaboration with the Vancouver Fraser Port Authority-led ECHO Program and the Prince Rupert Port Authority with the goal of notifying select regional commercial ship operators when whales are in their proximity. This awareness better enables vessels to undertake adaptive mitigation measures, such as slowing down or altering course in the presence of RKW and other cetaceans, to		

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		reduce the risk of collision and physical and acoustic disturbance (BC Cetacean Sightings Network 2020). • In 2019, the Whales in Our Waters online tutorial was developed for mariners by BC Ferries and the ECHO Program in partnership with Ocean Wise. The Whales in our Waters tutorial covers a range of topics to build awareness of local whale species, how to identify them, and best practices to implement when navigating ships in their presence such that potential interactions and physical and acoustic disturbance can be reduced (Port of Vancouver 2020a). • PCA is taking action, in collaboration with Indigenous groups and other federal departments, to support the recovery of SRKW through outreach, interpretation and education programs. These programs include messaging about shore-based whale watching, the BWW guidelines and the impacts of vessel noise on foraging and social behaviours. PCA Wardens also play an important role in on-the-water education directly to boaters (Kroeker pers. comm. 2021).		
Establishment of underwater vessel noise reduction measures[15]	Develop measures to reduce acoustic disturbance	• As part of the Ocean Protection Plan, the Government of Canada is developing an Ocean Noise Strategy, which will inform a whole of government approach to our understanding and management of ocean noise (DFO 2020a).[16] • In 2019, the Government of Canada implemented the Quiet Vessel Initiative, which is testing and evaluating the most promising technologies, vessel designs, retrofits, and operational practices to reduce underwater vessel noise. The Initiative is part of the Government of Canada's commitment to protect the marine	Objective 3: ensure that disturbance from human activities does not prevent the recovery of Resident Killer Whales	**DFO, TC, Vancouver Fraser Port Authority-led ECHO Program, Vancouver Fraser Port Authority,** Chamber of Shipping

[15] Additional performance measure added for reporting purposes to offer a more comprehensive assessment of implementation of activities under the broad strategy: 'Develop measures to reduce acoustic disturbance'.
[16] As a first step, a discussion document was launched in October 2020 for public comment as a way to provide information on ocean noise and gather feedback from all Canadians on the proposed framework for the strategy.

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		environment, and support the recovery of vulnerable marine mammals, including RKW (Transport Canada 2020). • In Fall 2019, TC's Innovation Centre launched a $21.1 million Request for Proposals to solicit low-noise and low-emission marine technology testing, demonstration, and deployment projects (Transport Canada 2019a).[17] • Canada recognizes the contribution of both domestic and international ships to underwater vessel noise in Canada, and that global commitment to measures are critical to international shipping and ship design. Therefore, commencing in 2017, TC has taken a leadership role on behalf of Canada at the International Maritime Organization (IMO) Marine Environment Protection Committee (MEPC) to promote international action and collaboration on underwater vessel noise amongst member states. TC has also collaborated to build the knowledge base and support for a new work output on underwater noise at the MEPC through the submission of several papers and proposals by Canada (International Maritime Organization 2019; Sanders pers. comm. 2020). • In addition, in 2019, an international benchmarking study regarding the IMO Guidelines for the reduction of underwater noise from commercial shipping to address adverse impacts on marine life (MEPC.1/Circ.833) (the Guidelines), was led by a steering committee that includes World Wildlife Fund Canada, the Chamber of Shipping of America, Environics Research, the World Maritime University, and TC. The study increased understanding of the uptake and awareness of the Guidelines amongst shipyards and ship owners, and informed a new work output request put forward by Australia, Canada, and the United States to the MEPC in December 2019 (Sanders pers. comm. 2020).		Council of Marine Carriers, Cruise Lines International Association, Indigenous groups, International Ship Owners Alliance of Canada, International stakeholders and member states of the International Maritime Organization (IMO), Pacific Pilotage Authority, Shipping Federation of Canada **T**

[17] This first annual call for proposals closed on January 20, 2020 and contracts are currently being awarded. Results from these projects will drive the adoption of these innovations, domestically and internationally.

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		• To inform Canada's work on underwater vessel noise, TC co-sponsored a workshop, hosted by the Canadian Network for Innovative Shipbuilding, Marine Research and Training, in November 2018 in Halifax, Nova Scotia. The workshop gathered 70 delegates from academia, industry, and government to discuss the latest developments in ship noise mitigation technologies and identified the most useful technical solutions to decrease underwater radiated noise (Sanders pers. comm. 2020). • TC has also taken advantage of existing bilateral, regional, and international opportunities to discuss anthropogenic underwater noise, including at the United Nations' Informal Consultative Process on Oceans and the Law of the Sea in June 2018 (Sanders pers. comm. 2020). • As part of TC's commitments under the Whales Initiative, TC is exploring the concept of Underwater Vessel Noise Management Plans (UVNMPs). UVNMPs are envisioned to be custom plans developed by fleet owners/operators to reduce their fleets' overall underwater noise over time using a combination of operational and technological measures. In January 2019, TC distributed a discussion document to Indigenous peoples and key stakeholders that outlined potential approaches to developing and implementing UVNMPs. Facilitated public engagement sessions were later held in February 2019 in Vancouver, Prince Rupert, Dartmouth, and by WebEx in Atlantic Canada and Quebec, to help advise on the development and implementation of UVNMPs. In late 2019, TC began working with stakeholders to create a National Working Group on Underwater Vessel Noise Reduction Targets to provide advice to the Government of Canada on possible reduction targets for underwater noise generated by vessels or fleets, which would ultimately inform the policy development on UVNMPs (Sanders pers. comm. 2020).		

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		• The Vancouver Fraser Port Authority-led ECHO Program has undertaken assessments of underwater shipping noise in the Salish Sea and its potential impacts, and has developed and tested potential means of reducing underwater noise exposure. • In 2017, the Vancouver Fraser Port Authority expanded its existing port incentive EcoAction Program to begin offering incentives for vessels with quiet ship classifications and technologies making Canada the first country in the world to encourage quieter ships. Ships calling on the Port of Vancouver that use technologies to reduce emissions, underwater noise, and other environmental effects can apply for reduced harbour dues of up to 47%. Each year since 2017, the port authority has increased the number of underwater noise reducing options eligible for discounted harbour dues through the program (Port of Vancouver 2020b). • In collaboration with its many partners, the ECHO Program implemented a voluntary slowdown of large commercial vessels during the summer of 2017 in Haro Strait. A peer reviewed study evaluating the 2017 slowdown compared measurements of vessels participating in the trial with measurements from control periods before and after the trial and showed that slowing down was an effective method for reducing mean broadband underwater noise source levels for all categories of piloted commercial vessels (MacGillivary et al. 2019). • Building on the success of the 2017 trial, a voluntary slowdown was put in place in Haro Strait during the summer of 2018. In 2019, the voluntary vessel slowdown trial expanded to include both Haro Strait and Boundary Pass, which were identified as key foraging areas for SRKW. Ship operators were encouraged to transit at reduced speeds through the voluntary vessel slowdown trial area (where it was safe and operationally feasible to do so) to reduce underwater vessel noise in nearby habitats, which is predicted to benefit the behaviour and feeding success of SRKW. Although the slowdown distance was almost doubled in 2019 over previous years, the Pacific Pilotage Authority reported that 82% of		

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		ship transits (1,279 of 1,551 transits) participated over the course of the slowdown, compared to 87% in 2018 and 61% in 2017 (Vancouver Fraser Port Authority 2020a). • In 2018, the ECHO Program also implemented a voluntary trial where all outbound deep sea vessels and inshore vessels (tugs) in a portion of the Strait of Juan de Fuca were requested to shift their passage further south, in an effort to reduce the impact of underwater noise from vessels in areas of critical importance to SRKW. In 2019, the trial focused on requesting inshore tugs to displace further south. Those inshore tugs achieved a participation rate of 76% and the hydrophone near Jordan River yielded a median reduction in broadband sound level of approximately 3.6 dB compared to the pre-trial period. Other factors, such as reductions in traffic and interim SRKW management measures implemented in the same area, likely also contributed to this reduction (Vancouver Fraser Port Authority 2020b). More details on the efficacy of the lateral vessel displacement in achieving underwater noise reductions are reported on by Vagle (2020). • In 2019, DFO and TC collaborated on the development and implementation of "A *Species at Risk Act* Section 11 Conservation Agreement to Support the Recovery of the Southern Resident Killer Whale" with the Vancouver Fraser Port Authority and six other member organizations of Vancouver Fraser Port Authority's ECHO Program (listed under participants). This Agreement was signed on May 10, 2019, and covers a five-year period following that date (2019 to 2024). The goal of this five-year agreement is to reduce acoustic and physical disturbance to SRKW from large commercial vessels that call on the Port of Vancouver or otherwise operate in SRKW critical habitat. The agreement commits the parties to do this through the development and implementation of threat reduction measures for SRKW recovery.		
Establishment of acoustic sanctuaries in	Develop measures to reduce	• In December 2018, Parliament approved amendments to the *Canada Shipping Act, 2001* (Justice Canada 2019), including strengthening safeguards to protect the marine environment from	Objective 3: ensure that disturbance from human	**Government of Canada,** BC Parks,

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
critical habitat areas	acoustic disturbance	the impacts of navigation and shipping activities, as well as the authority to make an interim order if immediate action is required to deal with a direct or indirect risk to the marine environment, including on a precautionary basis. • The Robson Bight-Michael Bigg Ecological Reserve is recognized as a sanctuary from most vessel traffic within NRKW critical habitat (BC Parks 2020). • In 2019, the Government of Canada announced a number of additional protection measures for SRKW[18]. Using the Interim Order Powers of the *Canadian Shipping Act, 2001*, TC put in place, three Interim Sanctuary Zones located within SRKW critical habitat at Swiftsure Bank, off the east coast of Saturna Island, and south-west of North Pender Island. General vessel traffic was prohibited (with exceptions) from entering these areas from June 1 to October 31 (DFO 2019a). The sanctuaries were based on recommendations from technical working groups that included representation from subject matter experts, including marine industry representatives, recreation boating and fishing community, government agencies, scientists, environmental groups, and US stakeholders. • Washington State placed a voluntary 'no-go' zone along western San Juan Island in 2018 (Washington Department of Fish and Wildlife 2018).	activities does not prevent the recovery of Resident Killer Whales	DFO, PCA TC, Washington State
Revised protocols for seismic and military sonar that reflect most recent understanding of physiological	Develop measures for reducing disturbance to high energy sources of sound	• The current Department of National Defense (DND) policy on marine mammal mitigation is contained in the Maritime Command Order 'Marine Mammal Mitigation Procedures for Active Sonar Use' (MARCORD 46-13). DFO and DND meet periodically to discuss marine mammal measures and revisions if required (Cottrell pers. comm. 2019). At this time, a scientific review of existing guidelines to assess impact of underwater sound	Objective 3: ensure that disturbance from human activities does not prevent the recovery of Resident Killer Whales	DFO, DND, NOAA

[18] SRKW management measures were updated and in effect again in 2020 and 2021 (DFO 2019a).

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
and behavioural responses to noise		including military sonar on marine mammals has not yet been completed. • DFO undertook a comprehensive review of the 2007 Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP) in protecting marine species. More detail on this process is reported in the related performance measure: “Complete controlled study of marine mammals in areas where seismic exploration is active” above. • NOAA Fisheries revised its Technical Guidance for Assessing the Effects of Anthropogenic Noise on Marine Mammal Hearing in 2018 (National Marine Fisheries Service 2018).		
Winter distribution of Resident Killer Whales well understood	Year-round surveys to identify important areas for Killer Whales	• Multi-species ship surveys are conducted annually by DFO. DFO’s Cetacean Research Program conducted 21 ship-based surveys between 2015 and 2019, six of which took place in the winter (two in October and four in March). The presence and location of RKW are recorded when observed (Doniol-Valcroze pers. comm. 2020). • Acoustic whale detections from PAM stations are also used to infer the distribution of RKW together with visual sightings. In Canadian waters, PAMs are deployed and maintained by DFO, TC, PCA (Gwaii Haanas; Lee pers. comm. 2020), Indigenous groups, and ENGOs (including NCCS, Pacific Wild, SIMRES, Ocean Networks Canada, and Orcalab) along the coast. DFO’s Cetacean Research Program completed 74 new deployments of autonomous PAMs between 2015 and 2019 in RKW habitats (Doniol-Valcroze pers. comm. 2020). • Killer Whale calls from PAM stations off Gowgaia Bay on the west coast of Gwaii Haanas from summer 2017 to summer 2019 were analyzed to family and clan; most RKW calls were identified to NRKWs (Lee pers. comm. 2021). • Burham et al. (2016) deployed a PAM recorder to identify Killer Whale presence during the winter months in Clayoquot Sound, on	Objective 4: protect critical habitat for Resident Killer Whales and identify additional potential areas for critical habitat designation and protection.	**DFO,** Academia, ENGOs, Indigenous Groups, NOAA, PCA, TC

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		the west coast of Vancouver Island. Both Resident and Transient Killer Whales were recorded, although analysis of vocalizations determined that the majority of the encounters recorded acoustically were of NRKW. • Two PAM recorders were deployed off the coast of Washington from 2004 to 2013: one off the continental shelf and the other on the shelf, off Cape Elizabeth. Residents were encountered primarily at site Cape Elizabeth and showed potential seasonal segregation between the two resident communities, with NRKW present mainly during summer and early fall when SRKW were not encountered (Rice et al. 2017). • The BC Cetacean Sightings Network (BCCSN), an initiative led by Ocean Wise, solicits sightings of cetaceans in BC waters from a network of observers comprised of coastal citizens, mariners, researchers, agencies, and ecotourism operators. Between 2015 and 2019, the BCCSN received over 11,500 sighting reports of Killer Whales; including 1625 confirmed reports of SRKW and 397 confirmed reports of NRKW (Barrett-Lennard pers. comm. 2020). Sighting reports provide valuable data that help inform the identification of important areas for RKW. During the period of this report, the BCCSN received annual funding through Government of Canada's HSP. • The Orca Network, located in Washington State, maintains a database of sightings of Killer Whales and other cetaceans sighted primarily in the Salish Sea, especially in the southern Strait of Georgia, San Juan Islands, and Puget Sound (The Orca Network 2019). • Under Canada's Oceans Protection Plan (see Transport Canada 2019b), ten passive acoustic monitors were deployed by DFO in areas within SRKW critical habitat that are likely to be affected by commercial vessel traffic (Swiftsure, Juan de Fuca Strait, Boundary Pass, and other locations). These recorders have been		

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		recording continuously since 2018 and are currently being analysed for SRKW detections (Thornton pers. comm. 2020). • The Whale Tracking Network, an Innovation Canada funded pilot project involving Ocean Sonics Ltd and DFO, began in 2015 and involves the development of a near real time detection system for SRKW in key areas within Canadian critical habitat. Currently this network of shore cabled acoustic monitoring nodes employs up to 20 hydrophones deployed on the West Coast of Vancouver Island, the Gulf Islands and the Northern Strait of Georgia to detect whale presence. Through this network of hydrophones, DFO can determine the whale pod, direction of travel, and the number of whales present (Cottrell pers. comm. 2020; Yurk pers. comm. 2020). • Data from acoustic detections were combined with opportunistic sightings and a limited number of satellite tagged whales to construct maps of habitat use for SRKW in the coastal waters of the US. Results indicated that in the winters of 2013 and 2015, tagged SRKWs spent the highest density of time located off the Columbia River and near Westport, Washington. Other areas with relatively high occurrence were off the northern coasts of Washington and California (Hanson et al. 2018).		
Winter prey of Resident Killer Whales identified	Identify key feeding areas and other critical habitat	• Information on winter prey of RKW was reported on above under the following performance measure: “Winter and spring distribution and diet of Resident Killer Whales identified” under objective 1. • In 2018, key foraging areas for SRKW were identified in SRKW critical habitat using best available science to inform salmon fishery management measures to support Chinook Salmon prey availability for SRKW (DFO 2018b).	Objective 4: protect critical habitat for Resident Killer Whales and identify additional potential areas for critical habitat designation and protection.	**DFO, NOAA**
Sanctuaries within critical habitat established	Protect access of whales to critical habitat	• The Robson Bight-Michael Bigg Ecological Reserve is recognized as a sanctuary from most vessel traffic within NRKW critical habitat. In the summer months, a BC Parks funded warden program provides support to on-water and observation platform monitoring and education (BC Parks 2020). The Robson Bight	Objective 4: protect critical habitat for Resident Killer Whales and identify additional potential	**Government of Canada,** BC Parks, Indigenous groups,

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		Guardian Watchmen program assists in reducing disturbance in the area by informing vessel operators of reserve boundaries and ways to minimize human impacts (Coastal First Nations 2019). This program received funding through the Aboriginal Fund for Species at Risk over the period of this report. • In 2019, the Government of Canada put in place a number of additional protection measures for SRKW under the *Canada Shipping Act*'s Interim Order, including the prohibition of general vessel traffic from entering three Interim Sanctuary Zones from June 1 to October 31, located at Swiftsure Bank, off the east coast of Saturna Island, and south-west of North Pender Island (DFO 2019a). • In 2019, under the *Canada Shipping Act's* Interim Order, an approach distance of 400 m was in effect between June 1 and October 31 within SRKW critical habitat (DFO 2019a). Voluntary measures were also implemented from May to October 2019, including avoiding fishing when within 1,000 m of Killer Whales in Enhanced Management Areas (which represent key foraging areas for SRKW), and encouraging boaters to slow down to 7 knots or less, turn off echo sounders if not in use, and turn engines to neutral idle when within 1,000 m of Killer Whales in SRKW critical habitat (DFO 2019a). • The Pacific Whale Watching Association guidelines adhere to a voluntary no-go zone on the west side of San Juan Island and commit to vessels staying outside of a 'Go Slow Zone' near Red Rocks Marine Protected Area when killer whales are present (PWWA 2019). • Washington State placed a voluntary 'no-go' zone along western San Juan Island in 2018 (Washington Department of Fish and Wildlife 2018).	areas for critical habitat designation and protection.	Industry, Washington State
Measurable reduction in	Protect critical habitat from	• Activities related to monitoring and evaluating trends in contaminants in critical habitat are captured under the	Objective 4: protect critical habitat for	**Government of Canada,**

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
contaminants in critical habitat	contamination and physical disturbance	performance measure: “Measurable decline in contaminant levels in environment (prey, sediments, etc.)” above under objective 2.	Resident Killer Whales and identify additional potential areas for critical habitat designation and protection	Academia,
Key prey populations in critical habitat areas	Ensure sufficient prey available to whales in critical habitat	• DFO Science is using a fisheries independent survey to estimate stock-specific Chinook Salmon abundance in the area around La Perouse Bank, in RKW critical habitat. Additionally, they are deploying acoustic tags on landed adult Chinook to estimate stock specific migration rates, habitat use, and survival during return migrations. Data from the tagging study, the escapement surveys, and results from a new statistical model, will be used to generate estimates of stock specific Chinook Salmon abundance, and availability as prey, throughout critical habitat in southern BC (Freshwater pers. comm. 2020). • Canada and the US have agreed to a new 10 year conservation and harvest sharing arrangement under the Pacific Salmon Treaty (DFO 2019c). Chapter 3 of the new agreement includes harvest reductions in both Canadian and US fisheries to help address ongoing conservation concerns for Chinook stocks in both countries. In addition, it includes renewed provisions for salmon enhancement (hatchery production), improved science/stock assessment and other measures to support rebuilding of Chinook stocks in both countries (Pacific Salmon Commission 2020). • The Chilliwack River Hatchery produces approximately one million Chilliwack River Chinook Salmon (identified as a high priority prey stock for SRKW) annually. The release of additional Chilliwack River Hatchery Chinook began in 2019 with the intent of increasing marine abundance and consequently the number of salmon available as SRKW prey. An initial increase of 300,000 additional fish occurred in 2019. The Government of Canada announced in October 2018 that an additional $2.53 million over five years would be used to increase juvenile	Objective 4: protect critical habitat for Resident Killer Whales and identify additional potential areas for critical habitat designation and protection.	**DFO,** Academia, Government of Canada, Indigenous groups, NOAA, PCA

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		Chinook production from the Chilliwack Hatchery (Government of Canada 2019c). • The $1.5 billion Oceans Protection Plan, launched in November 2016, is the largest investment the Government of Canada has ever made to protect our coasts and waterways. It includes funds to preserving and restore marine ecosystems, including close to $75 million for the Coastal Restoration Fund to support projects across BC that will help restore habitat for wild salmon and contribute to improving prey availability for SRKW (Transport Canada 2019b). Additionally, the Government of Canada and the Province of BC are investing up to $142.85 million over five years to support BC's fish and seafood sector, and to ensure the environmental and economic sustainability of wild Pacific salmon and other BC fish stocks. The Government of Canada also provided a one-time investment of $5 million for the Pacific Salmon Endowment Fund Society, while the Province of BC provided a one-time grant of $5 million to the Pacific Salmon Foundation (Government of Canada 2019a). • In October 2018, DFO completed the Wild Salmon Policy 2018 to 2022 Implementation Plan and the Cohen Response 2018 Status Update, as part of an integrated strategy to protect and rebuild wild salmon in BC (DFO 2018a). DFO has been working collaboratively with partners on the Southern BC Chinook Strategic Planning Initiative. One example of this collaborative work is the Integrated Strategic Plan for Southern BC Chinook, which the department has been co-developing with Indigenous groups and stakeholders over the last five years. The intent for the plan is to present a range of strategies that can be considered to address threats to BC southern Chinook from the collective perspective of a diverse group of Indigenous groups and interested parties (DFO 2019g). • PCA worked collaboratively with DFO, academia, ECCC and ENGO partners to identify important intertidal spawning habitat for		

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		salmon prey species in Pacific Rim National Park Reserve and Gulf Islands National Park Reserve (Kroeker pers. comm. 2021)[19]. • Since 2015, DFO, with support from PCA, has been collecting scat samples from Harbour Seals, Steller Sea Lions and California Sea Lions on a monthly basis from spring through fall at key locations and along salmon migratory pathways to estimate pinniped diets. In addition, updates to pinniped population assessments are pending final review (Majewski and Ellis in review; Majewski et al. in review). The goal is to estimate competition between pinnipeds and RKW for salmon prey. • In 2018, DFO reduced the Chinook commercial and recreational fishery in BC by an estimated 25% to 35% to help increase prey availability for RKW (DFO 2018c). In 2019, fisheries management measures were put in place to support the recovery of at risk Fraser River Chinook populations (Government of Canada 2019b). This was in addition to the suite of enhanced measures for protecting SRKW, including area based fishing closures for recreational and commercial salmon from August to October 2019, and a voluntary fishery avoidance zone within 1,000 m of Killer Whales (DFO 2019a). While there is currently no quantitative measure available to determine the effectiveness of these measures with regard to increasing prey accessibility to SRKW, they are put in place on a cautionary basis while an overall assessment of the relationship between noise, physical disturbance, and foraging habitat use is under investigation (Yurk pers. comm. 2020).		
Formal identification of critical habitat	Ensure trans-boundary cooperation in	• The transboundary waters of southern BC and Washington State are recognized as SRKW critical habitat under Canada's SARA, and the US *Endangered Species Act* (DFO 2018b; NOAA	Objective 4: protect critical habitat for	ECCC, EPA,

[19] In 2020, PCA worked collaboratively with DFO and academic partners to evaluate the use of remotely piloted aircrafts to identify important pelagic feeding areas of forage fish. This research supports understanding of food web integrity within Killer Whale critical habitats (Kroeker pers. comm. 2021).

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
recognized by international agreement	identification and protection of critical habitat	Fisheries 2020). Both the US and Canada engage at relevant steps in each other's respective critical habitat processes. In 2019, NOAA Fisheries proposed to expand SRKW critical habitat to include six new areas along the US West Coast. The six new areas include roughly 15,626 square miles of marine waters from the US-Canada border to Point Sur, California. Comments on this proposed rule and supporting documents were received up until December 18, 2019 (NOAA Fisheries 2020). • The Government of Canada continues to coordinate closely with US agencies in developing and implementing measures to reduce threats to SRKW. American representatives sit on Canadian threat based technical working groups. Similarly, Canadian representatives participate in Washington State's Southern Resident Orca Task Force (Southern Resident Orca Task Force 2019). • The annual SRKW population, based on data released by the Centre for Whale Research, is one of 10 reported Canada-US Transboundary Salish Sea Ecosystem Health Indicators, an initiative under the ECCC - US Environmental Protection Agency Joint Statement of Cooperation (SoC) on the Georgia Basin and Puget Sound Ecosystem (Government of Canada 2000; United States Environmental Protection Agency 2021). The SRKW indicator, reported since 2013, was originally developed to report on the State of Species in the Salish Sea, and is presented with indicators for Chinook salmon abundance and an evaluation of Marine Species at Risk. The indicator is periodically revised through a collaborative process among Canadian and US agencies and nongovernmental partners. The next published update to the Transboundary Salish Sea Ecosystem Health Indicators (including the SRKW Indicator) will be in 2021. The commitment to maintain and update the transboundary Salish Sea Ecosystem Health Indicators is identified as a priority action item described in the 2017 to 2020 Action Plan for the SoC (Environmental and Climate Change Canada and US Environmental Protection Agency 2017). The SoC is a non-legally	Resident Killer Whales and identify additional potential areas for critical habitat designation and protection.	Government of Canada, NOAA

Performance measure	Broad strategy	Activity description and results	Recovery goal/objective	Participants*
		binding agreement that outlines common goals and objectives for collaboration on transboundary ecosystem management of the Salish Sea. Facilitating the exchange of Salish Sea ecosystem related information across the border is an important goal of the SoC and can help identify priorities, as well as opportunities for effective coordination and cooperation.		

*Lead participant(s) is/are listed on top and in bold; other participants are listed alphabetically. Not all activities have specific participants identified.

3.2 Activities supporting the identification of critical habitat

Table 2 provides information on the implementation of the studies outlined in the schedule of studies to identify critical habitat of the recovery strategy. Each study has been assigned one of four statuses:

1) completed: the activity has been carried out and concluded
2) in progress[20]: the activity is underway and has not concluded
3) not started: the activity has been planned but has yet to start
4) cancelled: the activity will not be started or completed

Table 2. Status and details of the implementation of the schedule of studies outlined in the recovery strategy.

Study	Status	Description and Results	Participants*
Year-round comprehensive surveys to identify areas of occupancy	In progress	• Population censuses by photo-identification have been conducted on Northern Resident Killer Whales (NRKW) each year since 1973. NRKW census efforts tended to be geographically restricted to waters off northeastern Vancouver Island and temporally restricted to summer months (July and August) but in recent years the geographic range of the census effort has expanded to all coastal waters of British Columbia (BC) and the temporal range of photo-identification data has broadened as well (DFO 2019d). • Presence and location of Resident Killer Whale (RKW) were recorded during Fisheries and Oceans Canada (DFO) ship-based multi-species surveys (including an annual winter survey along the central and north coasts) between 2015 and 2019 (Doniol-Valcroze pers. comm. 2020). • The Parks Canada Agency (PCA) conducts visual marine mammal surveys in marine waters within and adjacent Pacific Rim National Park Reserve and Gulf Islands National Park Reserve and shares survey data with DFO (Kroeker pers. comm. 2021). • Passive acoustic monitoring (PAM) devices, including those within Southern Resident Killer Whale (SRKW) and NRKW critical habitat, allow for year-round acoustic monitoring and better understanding of Killer Whale distribution. Devices are deployed and maintained by DFO, Transport Canada (TC), PCA (Gwaii Haanas; Lee pers. comm. 2020), Indigenous groups, and Environmental Non-	**Center for Whale Research, DFO, NOAA,** Academia, ENGOs, Indigenous groups, PCA, TC

[20] Activities listed as “in progress” are often ongoing with no specific endpoint.

Study	Status	Description and Results	Participants*
		Governmental Organizations (ENGOs), including North Coast Cetacean Society, Pacific Wild, Saturna Island Marine Research and Education Society, Ocean Networks Canada, and Orcalab. • The Whale Tracking Network, maintained by DFO, employs 20 hydrophones deployed on the West Coast of Vancouver Island, the Gulf Islands and the Northern Strait of Georgia to detect whale presence. This project uses Artificial Intelligence programs collaboratively developed with Google to detect and alert whale presence and location in near real time through identification of calls, whistles and echolocation clicks (Cottrell pers. comm. 2020). • Two years of data from an autonomous PAM device deployed at Swiftsure Bank from 2009 to 2011 revealed SRKW were heard in all months, with activity peaking in the summer, while NRKW were also heard in all months but were mostly detected in spring and fall (Riera et al. 2019). The use of this area by both populations highlights the importance of Swiftsure Bank to both SRKW and NRKW, supporting the expansion of RKW critical habitat in 2018 to include this site[21]. • Two PAM recorders were deployed off the coast of Washington from 2004 to 2013: one off the continental shelf and the other on the shelf, off Cape Elizabeth. Residents were encountered primarily at site Cape Elizabeth and showed potential seasonal segregation between the two resident communities, with NRKW present mainly during summer and early fall when SRKW were not encountered (Rice et al. 2017). • Several organizations collect opportunistic cetacean sightings to aid in determining year-round distribution of Killer Whales. More information on sighting networks is provided in table 1 under objective 4. • With support from National Oceanic and Atmospheric Administration (NOAA), annual censuses for SRKW are led by the Center for Whale Research, with DFO contributing photographs to further support this effort each year (Doniol-Valcroze	

[21] In February 2020, a National Marine Mammal Peer Review Committee meeting reviewed the findings of a study that examined the frequency of use and seasonal occurrence of RKW on southwestern La Perouse Bank. The goal is to determine whether recent acoustic data support the currently published information that has identified La Perouse Bank as habitat necessary for the survival and/or recovery of RKW. The final version of the report is awaiting approval.

Study	Status	Description and Results	Participants*
		pers. comm. 2020; Hanson pers. comm. 2020). Photo identification catalogues for SRKW continue to be maintained and updated (Center for Whale Research 2019).	
Identify key feeding areas throughout the year to determine whether they should be proposed as additional critical habitat	In progress	• Fraser River stocks comprised 80% of the Chinook Salmon eaten by NRKW and SRKW off southwestern Vancouver Island and western Dixon Entrance (Ford et al. 2017). • Using data from opportunistic sightings networks, researchers found that the daily presence of SRKW could be predicted by escapement estimates of spring Chinook Salmon for the Fraser River and that both the use of the Salish Sea by SRKW and Chinook Salmon abundance has declined in the spring months since 2005. The researchers suggest that critical habitat designations be re-evaluated as SRKW shifts its range in response to prey availability (Shields et al. 2018).	**DFO,** Academia
Identify activities other than foraging that may be important functions of critical habitat	Completed	• Beach rubbing by NRKW takes place at specific traditional sites. Several of these sites are included in the NRKW critical habitat located in Johnstone Strait (DFO 2018b).	**DFO**
Identify sources of acoustic disturbance that may negatively impact or affect access to critical habitat	In progress	• Studies on ambient and anthropogenic noise in RKW habitat are summarized in table 1 under objective 3: “Acoustical and physical disturbance”. • The Vancouver Fraser Port Authority’s Enhancing Cetacean Habitat and Observation (ECHO) Program has undertaken assessments of underwater shipping noise in the Salish Sea and its potential impacts, as well as potential means of mitigating noise exposure. The ECHO Program was convened in 2014 and involves the transboundary collaboration of marine transportation industries, conservation groups, scientists, Indigenous groups and Canadian and United States (US) governments, including representatives from DFO, TC, NOAA and Canadian and US Coast Guards. ECHO’s efforts to reduce underwater noise are described in more detail in table 1 above. • TC has taken several actions to better understand underwater noise levels and associated impacts on SRKW. TC’s work to date is summarized in table 1 above.	**DFO**, **TC, Vancouver Fraser Port Authority-led ECHO Program,** Academia, Government of Canada
Identify sources of physical	In progress	• Vessel traffic near whales has been identified as a source of disturbance to RKWs in critical habitat (Ford et al. 2017).	**DFO,** Academia,

Study	Status	Description and Results	Participants*
disturbance that may negatively impact or affect access to critical habitat		• Data on vessels and whales near Robson Bight Michael Bigg Ecological Reserve were collected by DFO starting in 2018 to record the influence of vessels on NRKW rubbing beach use (Thornton pers. comm. 2020). • Vessel surveys for SRKW (presence) and behavioural assessments categorizing SRKW activity state were conducted starting in 2018. The study focuses on areas within RKW critical habitat, including Swiftsure Bank and Juan de Fuca Strait (Thornton pers. comm. 2020).	TC
Identify sources of biological and chemical contaminants that may negatively impact critical habitat	In progress	• Monitoring activities are conducted to help manage risk from toxic chemicals. Under the 2018 to 2023 Whales Initiative, Government of Canada science efforts focus on identifying key sources of contaminants and how they are entering aquatic environments, so that we will be in a better position to manage them (Government of Canada 2018d). Further details on efforts related to contaminants by the Government of Canada and partners are reported on in table 1 under objective 2.	**Environment Climate Change Canada,** Academia, BC Ministry of Agriculture, Food, and Fisheries (MoAFF), DFO, ENGOs, Metro Vancouver, PCA, Puget Sound Ecosystem Monitoring Program Toxics Working Group, Tsleil-Waututh Nation
Identify factors that may negatively affect an adequate and accessible supply of prey in areas of critical habitat	In progress	• Since 2015, DFO, with support from PCA, has been collecting scat samples from Harbour Seals, Steller Sea Lions, and California Sea Lions on a monthly basis from spring through fall at key locations and along salmon migratory pathways to estimate pinniped diets. In addition, updates to pinniped population assessments are pending final review (Majewski and Ellis in review; Majewski et al. in review). The goal is to estimate competition between pinnipeds and RKW for salmon prey. In 2019, University of British Columbia (UBC) convened a workshop to identify knowledge and uncertainties about the diets and population dynamics of pinnipeds, including possible impacts of pinnipeds on salmon in BC (Trites and	**DFO,** Academia, Salish Sea, Marine Survival Project, PCA

Study	Status	Description and Results	Participants*
		Rosen 2019). A second workshop was convened to: 1) provide concise summaries of the current state of scientific knowledge and uncertainties (Trites and Rosen 2019); 2) incorporate other relevant technical knowledge, outline management implications, and recommend possible next steps for science activities necessary to inform management considerations; and 3) ask participants to critique and provide feedback on four areas of action thought to possibly mitigate the impacts of pinnipeds on salmon: variation in hatchery production, enhanced fish survival, non-lethal removal of pinnipeds, and lethal removal of pinnipeds (Trzcinski 2020). • Under the 2018 to 2023 Whales Initiative (Government of Canada 2018d) and a further investment of $61.5 million to address principal anthropogenic threats to SRKW, four technical working groups and one ECHO Program advisory working group were established to support the development of management measures for protecting and recovering SRKW. The focus of one of these groups is prey availability, including evaluating short and long term measures that could be taken to increase food supply for SRKW. In 2018, commercial and recreational Chinook Salmon fisheries in BC were reduced by an estimated 25% to 35% to help increase prey availability for RKW (DFO 2018c). In 2019, the suite of SRKW management measures included area based fishing closures for recreational and commercial salmon from August to October 2019, and a voluntary fishery avoidance zone within 1,000 m of Killer Whales within key foraging areas in critical habitat (DFO 2019a). • The Salish Sea Marine Survival Project is a transboundary initiative investigating the physical, chemical, and biological factors affecting the survival of juvenile salmon and Steelhead in the Salish Sea. Research began in 2014 and is ongoing (Salish Sea Marine Survival Project 2020). • As reported on in table 1 above, UBC's Marine Mammal Research Unit held a technical workshop in 2017 on the availability of prey for SRKW. This workshop assembled scientists and managers with technical expertise on Killer Whales and Chinook Salmon to identify and evaluate short-term management actions that might increase the immediate abundance and accessibility of Chinook salmon for SRKW (Trites and Rosen 2018). Output from this workshop helped inform fisheries management measures taken for 2018 in support of threat abatement and recovery of SRKW.	

Study	Status	Description and Results	Participants*
		• Researchers at the University of Victoria are working to increase our understanding of SRKW echolocation in different underwater noise environments to investigate masking potential. This project involves working with DFO to conduct field-based acoustics measurements of echolocation clicks that as whales use to scan for food (Wladichuk pers. comm. 2020).	

*Lead participant(s) is/are listed on top and in bold; other participants are listed alphabetically. Not all activities have specific participants identified.

3.3 Summary of progress towards recovery

3.3.1 Status of performance measures

Activities are underway to support all forty performance measures from the recovery strategy that are reported on in table 1. Of the seven studies listed in the recovery strategy to support the identification of critical habitat that are reported on in table 2, six are underway and one is complete. While significant progress has been made, many of these activities are ongoing with no specific endpoint and therefore are not considered complete.

Progress towards performance measures may differ between NRKW and SRKW as some activities are specific to only one population; more funding initiatives (for example, the Whales Initiative and the Canada Nature Fund for Aquatic Species at Risk) and efforts have been directed towards the endangered SRKW because of the current population trajectory and the finding that SRKW are facing imminent threat to their survival and recovery (Government of Canada 2018c). In particular, there has been a concerted Government of Canada approach and effort to implement an enhanced suite of seasonal management measures to support SRKW recovery following the finding of imminent threat.

3.3.2 Completion of action plan

The “Action Plan for the Northern and Southern Resident Killer Whale (*Orcinus orca*) in Canada” was published in 2017 (DFO 2017a). It outlines recovery measures that provide the best chance of achieving the recovery objectives for the species, including the measures to be taken to address the threats and monitor the recovery of the species. Additionally, several multi-species action plans that include Resident Killer Whale (RKW) have been developed by the Parks Canada Agency (PCA) and posted to the Species at Risk Public Registry. These include the “Multi-species Action Plan for Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, and Haida Heritage Site” (Parks Canada Agency 2016); the “Multi-species Action Plan for Pacific Rim National Park Reserve of Canada” (Parks Canada Agency 2017); and the “Multi-species Action Plan for Gulf Islands National Park Reserve of Canada” (Parks Canada Agency 2018).

Shortly following the publication of the action plan, Fisheries and Oceans Canada (DFO) conducted a science-based review of the effectiveness of the current management and recovery actions in terms of their ability to abate threats to the recovery of SRKW, and summarized achievements to date on addressing the recovery measures identified in the RKW action plan (DFO 2017d). This review also identified vessel strikes as an additional emerging threat for SRKW (DFO 2017d). Further, a SRKW Symposium was held in Vancouver, British Columbia (BC) in 2017 to establish a collective understanding of the threats facing the SRKW and the actions needed for their protection and recovery. The symposium was supported by technical sessions on the primary threats to SRKW. A summary of the symposium is provided in a “What We Heard Report” (Government of Canada 2017).

3.3.3 Critical habitat identification and protection

Partial critical habitat was identified to the extent possible for both NRKW and SRKW in the 2008 recovery strategy. These critical habitat areas were protected through the making of a SARA Critical Habitat Order in 2009. In 2011, minor amendments were made to the critical habitat section of the 2008 recovery strategy. These amendments clarified that attributes of

critical habitat identified in the 2008 recovery strategy are a part of critical habitat. In 2018, the recovery strategy was further amended to include two additional areas of critical habitat (DFO 2018b). Now, critical habitat encompasses four distinct geographic areas: 1) the waters of Johnstone Strait and southeastern Queen Charlotte Strait (NRKW critical habitat); 2) transboundary waters in southern BC, including the southern Strait of Georgia, Haro Strait, and Juan de Fuca Strait (SRKW critical habitat); 3) waters on the continental shelf off southwestern Vancouver Island, including Swiftsure and La Perouse Banks (NRKW and SRKW critical habitat); and 4) waters of west Dixon Entrance, along the north coast of Graham Island from Langara to Rose Spit (NRKW critical habitat). A more complete description of the functions, features, and attributes that support the identification of critical habitat is provided in section 7 of the 2018 recovery strategy (DFO 2018b). The amendments to the recovery strategy are incorporated by reference in the two Critical Habitat Orders made in 2018 to protect the critical habitat of NRKW and SRKW respectively, which repealed and replaced the 2009 Order (Justice Canada 2018a; 2018b).

It is unknown if the critical habitat as identified in the 2018 recovery strategy is sufficient to achieve the populations' recovery goal and objectives. The recovery strategy states that there are likely other areas important to RKW at various times, but these areas have not yet been studied in sufficient detail to be identified with confidence. The schedule of studies outlines the research required to refine the understanding of the functions, features, and attributes of the currently identified critical habitat, to identify additional critical habitat necessary to support the populations' recovery goal and objectives, and to protect the critical habitat from destruction. Progress towards the implementation of the studies outlined in the schedule of studies was reported on in section 3.2 of this progress report.

3.3.4 Recovery feasibility

As stated in the recovery strategy, NRKW and SRKW populations are not expected to achieve high abundances because of their ecological position as upper trophic-level predators and their propensity to live in relatively small populations. Despite this, the recovery of both populations to a more robust and sustainable status was deemed technically and biologically feasible (DFO 2018b). Technologies and methodologies currently exist to reduce many of the threats facing Killer Whales, their prey, and their habitat. However, due to their small population size and existing threats, SRKW continue to have a high risk of extinction. In 2018, an Imminent Threat Assessment for SRKW was prepared by DFO in collaboration with PCA, Transport Canada, and Environment and Climate Change Canada. The outcome of the assessment indicated that SRKW are likely facing an imminent threat to recovery and survival unless current threats are mitigated (Government of Canada 2018c).

In 2019, DFO published results from a statistical model that quantitatively assessed the cumulative effects of the principal threats on the population trajectories of RKW (Murray et al. 2019). The model[22] outputs indicate that the average modelled NRKW population trajectory increases to the carrying capacity set in the model within 25 years, while the average modelled SRKW population trajectory declines, with a 26% probability of population extinction (within those projections mean time to SRKW extinction was 86 years) (Murray et al. 2019). Given data limitations and uncertainties for each of the principal threats to RKW and their impacts on mortality and birth rates, the cumulative effects model will need to be updated as new data become available, and as data about other potential threats emerge (Murray et al. 2019).

[22] The statistical model was based on recent threat levels, best available knowledge, and the assumption that no future mitigation will take place (Murray et al. 2019).

4. Concluding statement

Over the last five years, through the implementation of activities identified in the “Recovery Strategy for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada”, significant progress has been made to abate threats to the recovery of these populations. Through initiatives included in the $1.5 billion Oceans Protection Plan, the Government of Canada is demonstrating its commitment to sustain the economic, environmental, social, and cultural health of Canada’s oceans and coasts. In 2018, the Government of Canada announced an additional $167.4 million through the Whales Initiative, and following the finding of imminent threat to the survival and recovery of SRKW, an additional investment of $61.5 million over five years was announced to address threats to SRKW through contributing to research, monitoring, and the timely implementation of management measures (Government of Canada 2018d). These efforts have both direct and indirect positive impacts for NRKW recovery. Lastly, the $55 million Canada Nature Fund for Aquatic Species at Risk, launched in 2018 under Canada’s Nature Initiative, also provides funds to projects that help mitigate marine priority threats.

Over the period of this report, there have been strengthened protections and dedicated recovery efforts for Killer Whales through the amendment of the *Marine Mammal Regulations* under the *Fisheries Act,* the identification of two additional areas of critical habitat, and the implementation of the first seasonal management measures for SRKW. In particular, the suite of enhanced SRKW management measures implemented by the Government of Canada from June to August 2019 focused on threat abatement within SRKW critical habitat and will be directly reported on using a SRKW Monitoring and Assessment Framework consisting of a number of indicators and performance measures. The SRKW Monitoring and Assessment Framework will help inform the extent and type of any future interim management actions that may be taken to further support the survival and recovery of SRKW. Furthermore, in 2019, the Minister of Fisheries and Oceans, the Minister of Transport, and representatives in the shipping industry established a Section 11 Conservation Agreement to support the recovery of SRKW, demonstrating a shared commitment to reduce the acoustic and physical disturbance by large commercial vessels in Canadian Pacific waters (Government of Canada 2019d).

There have also been advancements in whale detection technology, acoustic monitoring systems, and research on the sources and impacts of contaminants. The progress made to date would not have been achieved without contributions from other federal agencies, provincial, municipal, and Indigenous governments, and environmental organizations. Together these efforts help to identify, monitor, and address threats to RKW, their prey, and their ocean habitat. DFO and PCA look forward to continuing these collaborations and welcome the contribution of additional partners.

The effects of recovery efforts can be expected to take multiple generations to be realized. The NRKW population has grown at a mean annual rate of 1.4% between 2015 and 2019 (DFO 2020b), while the SRKW population decreased from 81 to 73 individuals over that same time period (Center for Whale Research 2021). The Government of Canada remains committed to recovering Northern and Southern Resident Killer Whales and will continue to implement many recovery measures moving forward. The work started and completed to date has built a strong foundation for continued research and management of these populations over the next reporting period.

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