

Report on the Progress of Recovery Strategy Implementation for the Transient Killer Whale (*Orcinus orca*) in Canada for the Period 2013 to 2018

Transient Killer Whale



Photo: Christie McMillan

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Cover illustration: Transient Killer Whales by Christie McMillan

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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 minister(s) 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 (DFO) and the Minister responsible for the Parks Canada Agency are the competent ministers under SARA for the Transient Killer Whale and have prepared 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 DFO and the Parks Canada Agency, 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 Transient Killer Whale for the benefit of the species and Canadian society as a whole.

Acknowledgments

This report was prepared by Alannah Biega (DFO). To the extent possible, this progress report has been prepared with input from DFO Science, Fisheries Management, and Conservation and Protection; Parks Canada Agency, Environment and Climate Change Canada, Transport Canada, BC Ministry of Environment, Cetus Research and Conservation Society, and Ocean Wise Conservation Association. DFO would also like to express its appreciation to all individuals and organizations who have contributed to the recovery of the Transient Killer Whale.

Executive summary

The Transient Killer Whale (*Orcinus orca*) is acoustically, genetically and culturally distinct from other Killer Whale populations known to occupy waters off the coast of British Columbia. This population was designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as special concern in 1999 and re-examined and designated as threatened in November 2001. The population became legally listed on Schedule 1 with the proclamation of the *Species at Risk Act* (SARA) in 2003. In 2008, this population was assessed again and the threatened status was reaffirmed by COSEWIC. A [Recovery Strategy for the Transient Killer Whale \(*Orcinus orca*\) in Canada](#) (DFO 2007) was finalized and published on the Species at Risk Public Registry in 2007 and initial progress made towards recovery was reported on in the previous [Report on the Progress of Recovery Strategy Implementation for the Transient Killer Whale \(*Orcinus orca*\) in Canada for the Period 2007 to 2012](#) (DFO 2015). An action plan and amended recovery strategy for Transient Killer Whale (TKW) is currently in development for posting on the Species at Risk Public Registry.

The main threats identified for the TKW include contaminants, acoustic disturbance, physical disturbance from vessels and aircraft, collision with vessels, toxic spills (including both hydrocarbon and non-hydrocarbon spills), and changes in prey availability and/or quality.

The recovery goal for TKW as identified in the recovery strategy is to attain long-term viability of the West Coast TKW population by providing the conditions necessary to preserve the population's reproductive potential, genetic variation, and cultural continuity. In the absence of historical data, the recovery strategy does not identify a numerical target for a viable population; however, identified population, distribution, and recovery objectives are to serve as interim measures of recovery success.

The population objectives for the TKW are:

- the population size, averaged over the next five years, will remain at or above the current level
- the number of breeding females in the population, averaged over the next five years, will remain at levels that will provide a neutral or positive growth rate
- studies will be undertaken to determine numerical and demographic population objectives that represent long-term viability for this population

The distribution objectives for the TKW are:

- TKW will continue to utilize their known range
- prey will be available, in quantities adequate to support recovery, throughout the currently known range of TKW
- studies will be undertaken to determine how the range is utilized at a population and subpopulation level

The recovery objectives for the TKW are:

- minimize the exposure of legacy and emergent pollutants to TKW
- minimize the risk of prey population reductions from anthropogenic activities, until precise prey needs can be determined

- current measures to protect TKW from vessel disturbance will be maintained or modified, if determined necessary from further studies
- minimize the exposure of TKW to acute or chronic sound levels in excess of those considered to cause behavioural or physical harm in cetaceans
- the quantity, quality and distribution of TKW prey necessary to sustain or increase the current population level will be determined
- a greater understanding of the impacts of contaminants and other biological and non-biological pollutants on TKW will be developed
- the effects of vessel disturbance on TKW will be evaluated
- a more comprehensive understanding of the impacts of chronic and acute noise on TKW will be developed

This report summarizes the progress made towards achieving TKW recovery from 2013 to 2018, including achievements made by Fisheries and Oceans Canada (DFO) and other federal agencies, and highlights some of the known achievements of the broader conservation community. Progress during this timeframe includes:

- ongoing cetacean research efforts to collect data on TKW individuals across seasons, habitats, and years
- a new photo-identification catalogue, based on a 61-year archive of photo-identification data from 1958 to 2018
- progress in developing a more comprehensive understanding of population-level impacts of threats on TKW
- an improved understanding of foraging habitat and the range of TKW and their prey through dedicated and opportunistic surveys and sighting networks
- amendments to the Marine Mammal Regulations which provide further protection for TKW and their marine mammal prey
- an expanded outreach effort to mariners and the shipping industry to raise awareness of the presence of cetaceans and employ mitigation measures to reduce disturbance
- increased monitoring and sampling of air, sediment, and prey to measure levels of contaminants and assess trends
- the development of an action plan (underway) that includes measures to be taken to address the threats and monitor the recovery of the population
- the development of an amended recovery strategy (underway)

Starting in 2018, the Government of Canada has implemented additional enhanced seasonal management measures to support recovery of Southern Resident Killer Whales. These measures started in 2018 with seasonal fishing restrictions, and expanded in 2019 to include interim sanctuary zones, and an increased approach distance for Killer Whales (all ecotypes) to 400 m in areas of Southern Resident Killer Whale critical habitat. These additional measures were developed specifically for Southern Resident Killer Whales, but they have both indirect and direct benefits for TKW. While there has been measurable progress towards meeting the recovery goal and objectives presented in the recovery strategy, further work is required to support recovery of TKW in Canadian Pacific waters.

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1. Introduction

This report outlines the progress made towards meeting the population, distribution and recovery objectives listed in the Recovery Strategy for the Transient Killer Whale (*Orcinus orca*) in Canada (DFO 2007) from 2013 to 2018 and should be considered as one in a series of documents that should be taken into consideration together; including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report (COSEWIC 2008) and the Report on the Progress of Recovery Strategy Implementation for the Transient Killer Whale (*Orcinus orca*) in Canada for the Period 2007–2012 (DFO 2015). An amended recovery strategy and an action plan are currently in preparation for posting as proposed on the Species at Risk Public Registry.

Section 2 of this progress report summarizes key information on the threats to the population as well as population, distribution, and recovery objectives. For more details, readers should refer back to the recovery strategy. Section 3 reports on the implementation of approaches identified in the recovery strategy (from 2013 up to and including 2018) to support achieving the population, distribution, and recovery objectives. Section 4 summarizes the progress toward achieving the objectives.

2. Background

2.1 COSEWIC assessment summary

The listing of Transient Killer Whale (TKW) under the *Species at Risk Act* in 2003, which led to the development and publication of the Recovery Strategy for the Transient Killer Whale (*Orcinus orca*) in Canada in 2007, was based on the information provided in the COSEWIC Status Report (COSEWIC 2001). This information has also been included in section 1.1 of the recovery strategy. In 2008, COSEWIC re-examined and confirmed the status of TKW as threatened (COSEWIC 2008).

Common name:	Transient Killer Whale
Scientific name:	<i>Orcinus orca</i>
Legal listing (SARA):	Threatened
COSEWIC status:	Threatened
Assessment summary:	November 2008 ¹
Reason for designation:	This population has a very small number of mature individuals (~122). It is subject to threats from high levels of contaminants, acoustical and physical disturbance, and potential oil spills. However, the population has been increasing since the mid-1970s when monitoring began, and its prey base of pinnipeds and cetaceans is likely stable or increasing.
Occurrence in Canada:	Pacific Ocean
Status history:	Designated special concern in April 1999. Status re-examined and designated threatened in November 2001 and in November 2008.

¹ Assessment summary and population numbers are from COSEWIC 2008.

2.2 Threats

This section summarizes the information found in the recovery strategy on threats to survival and recovery of TKW.

2.2.1 Threats to the Transient Killer Whale

Table 1 summarizes the threats to TKW. Please refer to section 1.5 of the recovery strategy for more information on these threats.

Table 1. Summary of the threats identified for Transient Killer Whale (TKW), based on the recovery strategy.

Threat	Level of concern	Description
Contaminants	High	Persistent bioaccumulating toxins (PBTs) can be divided into legacy and emerging contaminants. PBTs can lead to direct toxic effects and can transfer (and bioaccumulate) to Killer Whales through prey. They can result in reproductive impairment, endocrine disruption, skeletal abnormalities, and cancer. Additionally, trace metals, such as mercury, can be found at elevated levels in urban and industrial areas, and may be of concern to Killer Whales, including TWK, and their prey.
Biological pollutants (that is, disease)	Unknown	TKW may be at heightened risk to the impacts of pathogens such as viruses, bacteria and macroparasites as a result of their specialization on marine mammals as prey. Prey species are vulnerable to these biological pollutants that can spread quickly throughout the marine environment, and impact Killer Whales directly or indirectly through physiological changes or disease in TKW, or reduced prey availability.
Toxic spills	High	Ingestion or exposure to toxic spills (for example, oil spills), including hydrocarbons, can result in physiological impacts and/or mortality.
Acoustic disturbance	Moderate (chronic) and high (acute)	Includes chronic noise from vessels and acute noise from intense impulsive sound (for example, from seismic surveys, military sonar, and underwater explosions). Chronic noise can result in masking of communication signals and inability to forage successfully, while acute noise can result in physiological impairment and possible physical harm (for example, from military sonar and underwater explosions) and/or behavioural effects.
Physical disturbance	High	Physical disturbance from recreational activities and vessel traffic can result in an interruption of foraging and social behaviours and can lead to possible displacement.
Collision with vessels	Low	Collisions with vessels can result in blunt force trauma and/or lacerations and may result in mortality either directly or indirectly (via infection).
Decline in prey availability and/or quality	Low (based on current pinniped and small cetacean abundance)	A reduction in prey via human consumptive use or culling could result in a lack of food for TKW. Contaminant loading in small cetacean and pinniped populations can also reduce quality and/or quantity of TKW prey.

2.2.2 Threats to critical habitat

Critical habitat for TKW has not yet been identified although habitat of special importance has been identified (Ford 2013; DFO 2013). Section 2.8.1 of the recovery strategy (DFO 2007) includes a schedule of studies that outlines the research required to identify critical habitat to achieve the population's distribution, population, and recovery objectives. Progress in undertaking the schedule of studies is reported in section 3.2 of this document.

2.3 Recovery

This section summarizes the population, distribution, and recovery objectives necessary for the recovery of TKW (DFO 2007).

2.3.1 Population, distribution, and recovery objectives

Section 2 of the recovery strategy (DFO 2007) identifies the following objectives necessary for the recovery of the species.

Population objectives

- the population size, averaged over the next five years, will remain at or above the current level
- the number of breeding females in the population, averaged over the next five years, will remain at levels that will provide a neutral or positive growth rate
- studies will be undertaken to determine numerical and demographic population objectives that represent long-term viability for this population

Distribution objectives

- TKW will continue to utilize their known range
- prey will be available, in quantities adequate to support recovery, throughout the currently known range of TKW
- studies will be undertaken to determine how the range is utilized at a population and sub-population level

Recovery objectives

- minimize the exposure of legacy and emergent pollutants to TKW
- minimize the risk of prey population reductions from anthropogenic activities, until precise prey needs can be determined
- current measures to protect TKW from vessel disturbance will be maintained or modified, if determined necessary from further studies
- minimize the exposure of TKW to acute or chronic sound levels in excess of those considered to cause behavioural or physical harm in cetaceans
- the quantity, quality and distribution of TKW prey necessary to sustain or increase the current population level will be determined
- a greater understanding of the impacts of contaminants and other biological and non-biological pollutants on TKW will be developed
- the effects of vessel disturbance on TKW will be evaluated
- a more comprehensive understanding of the impacts of chronic and acute noise on TKW will be developed

2.3.2 Performance measures

Performance measures are explicitly stated within the detailed objectives listed above. The progress towards these objectives will be informed by the progression made under the approaches in section 3.1 below.

3. Progress towards recovery

The recovery strategy for TKW divides the recovery effort into broad strategies that relate to the population, distribution, and recovery objectives in section 2 (DFO 2007). Broad strategies are further divided into recommended approaches to meet the objectives. Progress made towards these approaches is reported on in section 3.1. 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 performance measures 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 2 provides information on the implementation of activities undertaken to address the approaches and broad strategies identified in the recovery planning table of the recovery strategy.

Each approach has been assigned one of four statuses:

- 1) completed: the approach has been carried out and concluded
- 2) in progress: the approach is underway and has not concluded²
- 3) not started: the approach has been planned but has yet to start
- 4) cancelled: the approach will not be started or completed

Table 2. Details of activities supporting the recovery of the Transient Killer Whale (TKW) from 2013 to 2018.

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
P1 and P2: population size and demographic monitoring	Population census	Directed surveys	In progress	TKW are encountered and photo-identified in British Columbia (BC) during dedicated and opportunistic Fisheries and Oceans Canada (DFO) research trips (for example, multi-species surveys and acoustic deployments), as well as non-DFO research excursions and whale-watching activities. DFO maintains a database of these encounters made by DFO or reported by research collaborators (Doniol-Valcroze pers. comm. 2019). From 1958 to 2018, a total of 766 unique individual TKW	DFO , PCA

² Many of the activities listed as “in progress” are ongoing with no specific endpoint.

³ P, D and R represent population, distribution, and recovery objectives, respectively.

⁴ Lead participant(s) is/are listed on top and in bold; other participants are listed alphabetically. In the case where no single lead participant could be identified, none are bolded and participants are listed alphabetically.

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>were identified in a total of 6,277 encounters (Towers et al. 2019).⁵ Since 2012, the subset of TKW individuals that are most often observed in coastal BC waters has grown at an observed average annual rate of 4.1% due to relatively low mortality and the birth of over 100 calves during this time period (Towers et al. 2019).</p> <p>Parks Canada Agency (PCA) participates in marine mammal visual surveys and shares sighting data with DFO (Yakimishyn pers. comm. 2019, Lee pers. comm. 2020).</p>	
P1 and P2: population size and demographic monitoring	Population census	Collaborations with other TKW researchers	In progress	Monitoring TKW is a collaborative effort by researchers from DFO, PCA, Environmental Non-Government Organizations (ENGOS), Indigenous groups, industry, universities, and other contributors. Together these groups have contributed sighting reports, photographs, or field assistance that provided valuable insight into the population trends, abundance, and distribution of TKW (Towers et al. 2019). Coupled with this, data on TKW outside of Canadian waters has been compiled with the help of colleagues from	Academia, DFO, ENGOS, Indigenous groups, industry, PCA

⁵ While published in 2019, this catalogue is based on data collected up to and including 2018.

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>Alaska, Washington, Oregon, and California (Towers et al. 2019).</p> <p>The Aboriginal Fund for Species at Risk (AFSAR) has helped fund monitoring efforts of Indigenous groups along the BC coast. Over the period of this report, the Gitga'at First Nation, Nanwakolas Council, Namgis, and Haida First Nations (Lee pers. comm. 2020) helped document TKW distribution within their traditional territories.</p>	
<p>P1 and P2: population size and demographic monitoring</p>	<p>Population census</p>	<p>Formal and informal sightings networks including opportunistic photo-identification</p>	<p>In progress</p>	<p>TKW are encountered and photo-identified during dedicated and opportunistic research excursions. An updated catalogue of individual photographs of TKW from coastal BC, northern Washington, and southeastern Alaska was produced (Towers et al. 2019).</p> <p>The BC Cetacean Sightings Network (BCCSN), an initiative led by Ocean Wise Conservation Association, solicits sightings of cetaceans in BC waters from a network of observers comprised of coastal citizens, mariners, researchers, agencies, and ecotourism operators. During the period of this report, the BCCSN received annual funding through Government of Canada's Habitat</p>	<p>DFO, Ocean Wise, ENGOs PCA</p>

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>Stewardship Program (HSP). From 2013 to 2018, a total of 4,341 sightings of TKW were reported (Barrett-Lennard pers. comm. 2019).</p> <p>Strawberry Isle Marine Research Society collects photographs and behavioural data on TKW in Clayoquot Sound, BC. Data are shared with DFO and published in a Bigg's Killer Whale Identification Guide (Strawberry Isle Marine Research Society 2019).</p> <p>The Orca Network, located in Washington State, also 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).</p>	
P1 and P2: population size and demographic monitoring	Analytical modelling	Numerical and demographic population modelling	In progress	A demographic population model for TKW has not been updated since the capture-recapture model in Ford et al. (2009), however work towards an updated population assessment of TKW in Canadian Pacific waters is underway (Doniol-Valcroze pers. comm. 2019).	DFO
P3: setting demographic	Analytical modelling	Numerical and demographic	Not started	Numerical and demographic population objectives have not been	DFO

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
and numerical population objectives		population modelling		explicitly set. Ongoing population growth suggest that TKW are not yet at carrying capacity in coastal waters (Towers et al. 2019).	
D1 and D3: monitoring of range utilization	Population census	Directed surveys	In progress	<p>Cetacean research efforts reported on under objective P1 and P2 above were also used to monitor range use.</p> <p>Acoustic detections using hydrophone networks are also used to infer range of TKW. Hydrophones are deployed and maintained by DFO, PCA (Gwaii Haanas; Lee pers. comm. 2020), Indigenous groups, and ENGOS (including North Coast Cetacean Society, Pacific Wild, Saturna Island Marine Research and Education Society (SIMRES), and Orcalab) along the coast. From 2013 to 2018, DFO's Cetacean Research Program (CRP) completed 46 acoustic deployments in habitat where TKW could be encountered (Doniol-Valcroze pers. comm. 2019).</p>	DFO , ENGOS, Indigenous groups, PCA
D1 and D3: monitoring of range utilization	Population census	Collaborations with other TKW researchers	In progress	Collaborations reported on under objective P1 and P2 above were also used to monitor range use.	Academia, DFO, ENGOS, Indigenous groups, industry, PCA
D1 and D3: monitoring of	Population census	Formal and informal sightings	In progress	Sightings networks reported on under objective P1 and P2 above were also used to monitor range use.	DFO, Ocean Wise , ENGOS, PCA

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
range utilization		networks including opportunistic photo-identification			
D2: monitoring of prey distribution	Population monitoring	Pinniped surveys	In progress	<p>Aerial surveys of Steller Sea Lions off the BC coast are conducted every four years as part of range-wide breeding season surveys undertaken by DFO and the National Oceanic and Atmospheric Administration (NOAA). Analysis of Canadian aerial survey data collected between 2010 and 2013 indicates that the Canadian population has been growing rapidly, with non-pup counts increasing from an average of 4,860 (SE = 254) between 1971 to 1982 surveys to 22,135 individuals in the 2013 breeding season survey; growing at an average annual rate of 3.8% (Olesiuk 2018). The most recent survey was conducted in 2016 to 2017; analysis from this survey is in progress although preliminary results suggest that the Steller Sea Lion population in BC is growing (Majewski pers. comm. 2019).</p> <p>DFO conducts aerial surveys for Harbour Seals in the Strait of Georgia every five years and other areas of the coast on a five to ten year</p>	DFO, NOAA, PCA

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>rotation. The most recent survey in the Strait of Georgia occurred in 2018 and a coast-wide analysis of distribution and population trends is ongoing (Majewski pers. comm. 2019).</p> <p>PCA continues to conduct boat-based counts of Steller Sea Lions at three haul-out sites in Pacific Rim National Park Reserve during summer months (Yakimishyn pers. comm. 2019). PCA has also collaborated with DFO in Gwaii Haanas to conduct aerial surveys of Sea Lion summer haulouts and rookeries, and Harbour Seal counts in 2017 and intends to continue collaborating with DFO to conduct future surveys in Gwaii Haanas (Lee pers. comm. 2020).</p>	
D2: monitoring of prey distribution	Population monitoring	Formal and informal sightings networks for small cetaceans	In progress	<p>The presence and location of small cetaceans is recorded during DFO dedicated and opportunistic research excursions. PCA opportunistically records the presence and location of small cetaceans in Pacific Rim National Park Reserve and Gwaii Haanas and shares sighting data with DFO (Yakimishyn pers. comm. 2019 and Lee pers. comm. 2020).</p> <p>The BCCSN maintains a database of cetacean sightings in BC waters from</p>	DFO, ENGOS, PCA

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>a network of observers comprised of coastal citizens, mariners, researchers, agencies, and ecotourism operators (The BC Cetacean Sightings Network 2018). The Porpoise Conservation Society collects sightings of Harbour Porpoise from the general public to learn more about species distribution, abundance, and habitat use (Porpoise Conservation Society 2019).</p>	
<p>R1: reducing contaminants in TKW and their prey</p>	<p>Regulations & prohibitions</p>	<p>Maintain and enforce existing prohibition on regulated Polychlorinated terphenyls (PCTs) and other non-polybutylene terephthalate (PBT) chemicals</p>	<p>In progress</p>	<p>Polychlorinated biphenyls (PCBs) have been restricted since 1991 and the phase out of these substances accelerated in 2008 with publication of the PCB Regulations (SOR/2008-273). The purpose of the regulations is to protect the health of Canadians and the environment by preventing the release of PCBs to the environment, and by accelerating the phasing out of these substances. The most recent amendments to these regulations came into force in 2015 (Government of Canada 2015a).</p> <p>Environmental quality guidelines for the protection of aquatic life are derived for water, sediment and tissue by the Canadian Council of Ministers of the Environment (CCME) and the BC Ministry of Environment</p>	<p>Environment and Climate Change Canada (ECCC), BC Ministry of Environment and Climate Change</p>

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				and Climate Change Strategy (British Columbia Ministry of Environment and Climate Change Strategy 2019).	
R1: reducing contaminants in TKW and their prey	Regulations & prohibitions	Evaluate the need for, and efficacy of, prohibitions on use of unregulated polybrominated diphenyl ethers (PBDEs) and other non-PBTs that affect TKW or their prey and implement mitigation measures as necessary	In progress	<p>In December 2018, the Government of Canada published a consultation document proposing to strengthen the regulatory controls for PBDEs and four other persistent organic pollutants that are listed as toxic under section 64 of the <i>Canadian Environmental Protection Act, 1999</i> (CEPA 1999; Government of Canada 1999). The consultation document proposed to strengthen the regulatory controls by amending the Prohibition of Certain Toxic Substances Regulations (PCTSR) to remove existing exemptions, or provide time limits on the exemptions, such that the substances are phased out of use.</p> <p>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 1999) 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</p>	ECCC , academia, Canadian Water Network, State of Washington Department of Ecology

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>Proposed Regulations amending the PCTSR are expected to be published in 2020 (Government of Canada 2018).</p> <p>A study conducted by Johannessen et al. (2015) found that municipal effluent discharged into the Strait of Georgia contributes 60% of PBDEs captured in the sediment.</p> <p>The Government funded a Canadian Water Network-led national expert panel to review existing and emergent contaminants in wastewater systems and the technologies available to remove them. Results of the review have been published and can be found on the Canadian Water Network website (Canadian Water Network 2018).</p> <p>Wastewater Systems Effluent Regulations (SOR/2012-139) reduce the threats to fish and fish habitat by setting out effluent release standards (Government of Canada 2015b). Wastewater systems that do not meet the effluent release standards outlined in the Wastewater Systems Effluent Regulations must upgrade their treatment systems to include secondary treatment which is able to</p>	

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>remove approximately 90% of some pollutants such as PBDEs.</p> <p>The Government of Canada provided up to \$400 million in funding for wastewater treatment plant upgrades in Victoria and North Vancouver through the Investing in Canada long-term infrastructure plan (Government of Canada 2017).</p> <p>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).</p>	
R1: reducing contaminants in TKW and their prey	Regulations & prohibitions	International cooperation and collaboration to reduce PBTs used outside Canada that contribute to Canadian contaminant levels	In progress	<p>Canada is a party to a number of legally binding international environmental agreements to reduce persistent contaminants that could contribute to Canadian contaminant levels. These include:</p> <ul style="list-style-type: none"> • Stockholm Convention on Persistent Organic Pollutants • Basel Convention on the Control of Transboundary Movements of 	ECCC , EPA, Puget Sound Ecosystem Monitoring Program, Washington State Department of Fish and Wildlife

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>Hazardous Wastes and Their Disposal</p> <ul style="list-style-type: none"> • Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade • United Nations Economic Commission for Europe (UNECE) • Convention on Long-Range Transboundary Air Pollution (LRTAP) <p>The Puget Sound Ecosystem Monitoring Program’s (PSEMP) toxics workgroup meets bi-monthly and focuses on improving toxics-related monitoring by encouraging coordination and collaboration, identifying priorities and gaps, and increasing knowledge and understanding (PSEMP Toxics Work Group 2019). Their recent monitoring and research activities focused on toxic contaminants in the Salish Sea are reported on in the 2018 Salish Sea Toxics Monitoring Synthesis (PSEMP Toxics Work Group 2019).</p> <p>Washington State’s Southern Resident Orca Task Force established a Toxics working group, which includes a Canadian</p>	

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>representative from ECCC. The Task Force submitted its first set of recommendations to the Washington State Governor in 2018. These included five recommendations aimed at reducing the exposure of contaminants to Southern Resident Killer Whales (SRKW) and their prey. If adopted, these measures would also benefit TKW (Southern Resident Orca Task Force 2018). Similarly, American representatives sit on the ECCC-led Canadian Contaminant Working Group.</p> <p>In 2000, ECCC and the United States (US) Environment Protection Agency (EPA) signed a Statement of Cooperation (SoC) that outlines common goals for the health of the Salish Sea ecosystem. The two agencies maintain a working group that develops and updates an action plan to achieve these goals. The 2017 to 2020 action plan includes a commitment to strengthening transboundary information exchange, supported through a biennial Salish Sea Ecosystem Conference and the Health of the Salish Sea Ecosystem Indicators Report (ECCC and EPA 2017).</p>	

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
R1: reducing contaminants in TKW and their prey	Stewardship & education	Government and non-government education and stewardship programs for industrial and private use of PBT and non-PBT compounds including currently used pesticides	In progress	<p>The Pacific Region Contaminants Atlas is an online educational tool designed to explore environmental contaminant topics in BC. It was last updated in 2016 (The Community Mapping Network 2016).</p> <p>Since 1991, Trout Unlimited Canada has maintained their Yellow Fish Road program, a storm drain marking program that helps educate on how to prevent pollutants from entering storm drains (Trout Unlimited Canada 2019). Similarly, in collaboration with DFO, the City of Vancouver maintains a catch basin marking program in which citizens paint yellow fish on Vancouver’s catch basins to serve as a reminder that what is poured down the drain can harm rivers and oceans (The City of Vancouver 2019).</p> <p>The Georgia Strait Alliance’s ToxicSmart program contains outreach materials that help inform how to reduce the use of toxic chemicals in the home (Georgia Strait Alliance 2019). Several other ENGOs also include messaging on the effects of contaminants on Killer Whales.</p>	DFO, ENGOs The City of Vancouver, The Community Mapping Network, Trout Unlimited Canada
R1: reducing contaminants	Contaminant monitoring	Dedicated sampling	In progress	Biopsy samples have been collected from TKW opportunistically during cetacean research excursions. Tissue	DFO, NOAA, Ocean Wise

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
in TKW and their prey		program for TKW		<p>samples from recently dead and non-emaciated TKW have also been collected during necropsies (Cottrell pers. comm. 2019).</p> <p>DFO, in collaboration with NOAA and Ocean Wise, has examined contaminant concentrations and metabolites in Killer Whale populations. From 2016 to 2018, three TKW biopsy samples were collected (Noel pers. comm. 2019)⁶. Samples have been analyzed for PCBs and PBDEs and the data are currently being processed. DNA extraction and sequencing of the major histocompatibility complex (MHC) region of the genome (to assess immune system diversity) has also been completed (Barrett-Lennard pers. comm. 2019). Skin of biopsy samples will be analysed for mercury (Brown pers. comm. 2019).</p>	
R1: reducing contaminants in TKW and their prey	Contaminant monitoring	Dedicated sampling program for Harbour Seals	In progress	In collaboration with NOAA, DFO, and the Washington State Department of Fish and Wildlife, Ocean Wise collects blubber biopsy samples from Harbour Seals to monitor levels of PBT contaminants including PCBs, PBDEs, and	DFO, NOAA, Ocean Wise, Washington State Department of Fish and Wildlife

⁶ Six additional biopsy samples were collected from TKW in 2019 (Barrett-Lennard pers. comm. 2019).

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>pesticides. The most recent sampling of Harbour Seals occurred in 2018 and samples are currently being processed for PCB, PBDEs, pharmaceuticals, and perfluorinated compounds (PFCs) (Noel pers. comm. 2019). Transcriptomics and metabolomics analyses have also been conducted on blubber biopsy samples collected in 2014, 2015, and 2018 (Noel pers. comm. 2019).</p> <p>According to the Health of the Salish Sea Ecosystem Report, PCB concentrations declined in Harbour Seals from 1984 to 2010 and levels of PBDEs appear to have peaked in 2003, following a rapid increase since 1984 (EPA 2019).</p>	
R1: reducing contaminants in TKW and their prey	Contaminant monitoring	Benchmark studies for other important prey species (other pinnipeds and cetaceans)	In progress	<p>Relatively high concentrations of PBDEs have been observed in Steller Sea Lions in the range of 50µg/kg (lipid weight) in adult females to 3776 µg/kg in subadult individuals (Alava et al. 2012).</p> <p>Recent research supports the biomagnification of PCB congeners in tissues of Steller Sea Lions in Alaska (Beckmen et al. 2016).</p>	Academia
R1: reducing contaminants	Contaminant monitoring	Sediment sampling and	In progress	The Government of Canada's Chemicals Management Plan (CMP),	ECCC

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
in TKW and their prey		monitoring (provides link to model food web bioaccumulation & link to sediment quality guidelines)		<p>which has been in place since 2006, aims to reduce the risks posed by chemicals to Canadians and the environment. 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. The Minister of Health and the Minister of Environment and Climate Change have committed to addressing 4,300 priority chemicals by 2020 (Government of Canada 2016). Monitoring activities are conducted to support the undertaking of risk assessments and managing the risks from toxic chemicals.</p> <p>Under the 2018 to 2023 Whales Initiative, 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 (Government of Canada 2020). These efforts will include:</p> <ul style="list-style-type: none"> air monitoring to measure contaminant transport and deposition from distant and local sources such as urban 	academia, Indigenous groups, Ocean Wise, PCA

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>areas to habitat for Killer Whales and their prey</p> <ul style="list-style-type: none"> • increased freshwater and sediment sampling within the Fraser River watershed to identify presence of contaminants that may impact SRKW and/or their prey • landfill leachate sampling of contaminants of concern at 10 municipal solid waste landfill sites in Canada to confirm whether specific contaminants are being released from landfills in concentrations and loadings that would pose a risk to Killer Whales • increased sediment sampling at disposal at sea locations and their vicinity to monitor for priority contaminants that may impact Killer Whales <p>Alava et al. (2016) developed a food web bioaccumulation model designed to estimate the PBDE concentrations in Resident Killer Whales based on concentrations in sediments and the water column throughout a lifetime of exposure. Calculated and observed PBDE concentrations exceeded the only toxicity reference value available for PBDEs in marine mammals (1500</p>	

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>µg/kg lipid) in SRKW (Hall et al. 2003). Given that TKW feed higher in the food web than SRKW, PBDE concentrations in TKW are also likely to exceed this reference value.</p> <p>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 2019). Phase 2 sample collection will be wrapping up in fall 2019 (Noel pers. comm. 2019). Parks Canada 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).</p>	
R1: reducing contaminants in TKW and their prey	Contaminant monitoring	Necropsy stranded TKW to evaluate possible exposure to contaminants, biological pollutants & pathogens	In progress	From 2013 to 2018, five TKWs were necropsied through the Marine Mammal Response Program (Cottrell pers. comm. 2019). Necropsy protocols for Killer Whales have been updated; goals of the revised protocols include improving understanding of disease in Killer Whales and of the effects of contaminants and heavy metals on	BC Ministry of Agriculture, Food and Fisheries, DFO

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				Killer Whale health (Raverty et al. 2014).	
R2: protecting prey population	Pinniped harvest protection	Maintain current harvest restrictions and ensure research, nuisance seal or other authorized removals do not cause pinniped population level reductions	In progress	<p>Harvest restrictions on pinnipeds have been maintained. Pinnipeds are further protected under the Marine Mammal Regulations which are pursuant to the <i>Fisheries Act</i>, last amended in 2018 (DFO 2018).</p> <p>Potential Biological Removal has not been calculated for Steller Sea Lions in Canadian waters. COSEWIC (2013) indicates that based on growth of the Steller Sea Lion population, anthropogenic threats may be within sustainable levels.</p>	DFO
R2: protecting prey population	Small cetacean protection	Maintain harvest restrictions and develop and/or maintain programs to protect small cetaceans from anthropomorphic threats	In progress	<p>Harvest restrictions on small cetaceans have been maintained. All cetaceans are protected under Canada's Marine Mammal Regulations which are pursuant to the <i>Fisheries Act</i>, last amended in 2018 (DFO 2018).</p> <p>DFO Policy for Managing Bycatch (DFO 2013) provides recommendations of priorities for data collection and monitoring to assess the need for requirements on measures to reduce bycatch of all species, including marine mammals.</p>	DFO, ENGOs, NOAA, PCA

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>The Marine Mammal Response Program (MMRP) responds to live stranded, injured and dead cetacean reports. On average, the MMRP collects threat information through conducting sampling and/or necropsies of over 30 small cetacean carcasses annually (Cottrell pers. comm. 2019). PCA contributes to data collection and coordinating responses for marine mammals in distress within park reserve boundaries (Cardinal pers. comm. 2019; Lee pers. comm. 2019). In the US, the West Coast Marine Mammal Stranding Networks respond to stranding along the coasts of Washington, Oregon, and California (Carretta et al. 2018).</p> <p>The Marine Education and Research Society (MERS) monitors marine mammals, including small cetaceans, during times of high whale/fishery overlap around Vancouver Island and the central BC coast to improve entanglement response and data collection (MERS 2019).</p> <p>Please see activities under objectives R3 and R4 below for further action taken to protect small cetaceans from anthropogenic threats.</p>	

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
R3: protecting TKW from vessel disturbance	Regulations	Implement the proposed Marine Mammal Regulation amendments of the <i>Fisheries Act</i>	Completed	The amendments to the Marine Mammal Regulations of the <i>Fisheries Act</i> were implemented in 2018. These amendments 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 (DFO 2018).	DFO
R3: protecting TKW from vessel disturbance	Stewardship & education	Government and non-government education and stewardship programs aimed at reducing vessel disturbance	In progress	<p>DFO provides information about the “Be Whale Wise” (BWW) guidelines to stakeholders, the fishing industry, ENGOs working on the water, and members of the public. BWW is a partnership of governmental agencies, ENGOs and other stakeholders in the Salish Sea to research, implement, and educate best vessel practices around whales (Be Whale Wise 2019). These 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).</p> <p>PCA is working towards minimizing disturbance to marine mammals from visitor boats by promoting compliance with BWW guidelines through visitor orientations, business licencing, and</p>	DFO, ENGOs, Indigenous groups, PCA, Port of Prince Rupert, TC, ECHO Program

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>public outreach and education events and programs (Parks Canada Agency 2016; Yakimishyn pers. comm. 2019; Lee pers. comm. 2020). At Gulf Islands National Park Reserve, PCA provides information of BWW guidelines and other relevant policies to business license holders (approximately 33 annually), at special events, and to general visitors out in the park reserve (Cardinal pers. comm. 2019).</p> <p>DFO’s Habitat Stewardship Program (HSP) funds stewardship and outreach activities by various groups; the BCCSN, BC Ferries, Cetus, MERS, North Coast Cetacean Society (NCCS), and SIMRES all promote BWW guidelines and responsible vessel operation around marine mammals through presentations, signage, and other outreach materials. Straitwatch, Soundwatch (in US waters), and the Robson Bight Marine Warden Program provide direct on-water education to vessel operators.</p> <p>Through the Haida Gwaii Marine Stewardship Group led by the Council of the Haida Nation, in partnership with PCA, DFO, Laskeek Bay</p>	

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>Conservation Society, and Skidegate and Old Masset Band Councils, deliver a public awareness program that contributes to human behavioral changes and increases compliance with marine mammal viewing guidelines. Gitga'at First Nation and Namgis First Nation inform fishing lodges and vessel operators from the North Coast of BC and Vancouver Island of appropriate marine mammal viewing protocols.</p> <p>In 2016, a Mariner's Guide was developed from a partnership between the Vancouver Fraser Port Authority, Prince Rupert Port Authority, and Ocean Wise targeted at large vessel mariners. The guide informs about the cetacean species along the BC coast, threats to these animals that may be associated with large vessels and shipping, and how mariners can minimize these threats (Coastal Ocean Research Institute 2016). In 2018, Ocean Wise launched the WhaleReport Alert System (WRAS); an alert system that uses sightings submitted to the BCCSN to notify marine pilots and shipmasters of cetaceans within 10 nautical miles of their vessel so that they can slow down or divert course to reduce the</p>	

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>risk of strike or disturbance (The BC Cetacean Sightings Network 2018).</p> <p>The Vancouver Fraser Port Authority-led ECHO Program, in collaboration with its many partners, implemented a voluntary slowdown of large commercial vessels during the summer of 2017 in Haro Strait; a peer reviewed study evaluating the 2017 slowdown showed that slowing down was an effective method for reducing mean broadband underwater noise source levels for all categories of piloted commercial vessels (MacGillivray et al. 2019). A voluntary slowdown was put in place in Haro Strait during the summer of 2018. 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. More details on the efficacy of the lateral vessel displacement in achieving underwater noise reductions are reported on by Vagle (2020). While these efforts were directed at the endangered</p>	

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>SRKW, they could have indirect positive effects for TKW.</p> <p>Transport Canada (TC) implemented changes in 2018 to the mandatory content of the course and test for obtaining a Pleasure Craft Operator Card. The updated requirements include information pertaining to safe operations around whales (McKay pers. comm. 2019).</p>	
R3: protecting TKW from vessel disturbance	Guidelines	Amend as necessary and/or develop species or area specific guidelines for viewing of TKW	In progress	<p>The 2018 amendments to the Marine Mammal Regulations under the <i>Fisheries Act</i> 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 (DFO 2018).⁷</p> <p>The Pacific Whale Watch Association (PWWA) have their own set of dynamic whale viewing guidelines, which are modified frequently to adjust for the best available science (Pacific Whale Watch Association 2019).⁸</p>	DFO, ENGOs, NIMSA, PCA, PWWA

⁷ In 2019, the Government of Canada announced a number of additional protection measures for Killer Whales, including increasing the distance between vessels and Killer Whales to a minimum of 400 m, with some exceptions, in SRKW critical habitat in southern BC and southwest Vancouver Island waters. For a complete overview of the mandatory and voluntary management measures, including fishing closures, interim sanctuary zones, approach distances, and boating guidelines for vessel speeds and the use of echosounders, please see DFO 2020.

⁸ The PWWA last modified their voluntary guidelines in 2019.

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>In addition to the BWW guidelines, the North Island Marine Mammal Stewardship Association (NIMMSA) 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).</p> <p>Land-based whale watching initiatives, such as The Whale Trail, inspire marine mammal stewardship and offer a lower-impact alternative for viewing TKW. Founded in 2008 in Washington State, The Whale Trail then extended to BC in 2015 through cooperation with Ocean Wise. Since then, 14 whale trail locations have been established in BC (Barrett-Lennard pers. comm. 2019).</p>	
R3: protecting TKW from vessel disturbance	Enforcement & monitoring	Continue and modify, as necessary, enforcement and monitoring programs directed to compliancy with guidelines and regulations	In progress	The DFO Conservation and Protection (C&P) program facilitates public compliance with the <i>Fisheries Act</i> , including enforcement of the Marine Mammal Regulations in Canadian Pacific waters. 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	DFO , ENGOs, Indigenous groups, PCA

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>watching guidelines. Under the Oceans Protection Program, C&P is funded to build capacity to support marine mammal response incidents, which includes following up with marine mammal incident reports. Additionally, the Fisheries Aerial Surveillance and Enforcement Program is tasked with recording cetaceans and relaying incidents of harassment to local Fishery Officers.⁹</p> <p>PCA wardens and field staff monitor and report on activities in marine park reserves and national marine conservation areas to ensure that regulations are followed (Lee pers. comm. 2020).</p> <p>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 (Cetus Research and Conservation Society 2019). Specific to the waters in and around Robson Bight Ecological Reserve, the Robson Bight</p>	

⁹ 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).

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>Marine Warden program patrols the perimeter of the reserve and ensures that no boats enter it (Cetus Research and Conservation Society 2019).</p> <p>The Coastal Guardian Watchmen Program is a territorial stewardship program comprised of First Nations 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 to ensure that regulations are followed (Coastal First Nations 2019).</p>	
R3: protecting TKW from vessel disturbance	Enforcement & monitoring	Evaluate the efficacy of enforcement and education programs, and develop as necessary new approaches and protocols for TKW	In progress	The Straitwatch Program, operated by Cetus Research and Conservation Society, continues to monitor marine vessel and Killer Whale interactions in the waters around Vancouver Island. Straitwatch contacts boaters for education and incident prevention purposes, or if vessels are displaying inappropriate behaviours around whales. Of the boaters contacted in the 2018 season, approximately half were self-reportedly aware of the Marine Mammal Regulations and Be Whale Wise guidelines (Dombowsky pers. comm. 2019).	DFO, ENGOs

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>The number of large whale harassment incidents reported to the Marine Mammal Response Program was 34 (88% involving Killer Whales) in 2013 and 90 (69% involving Killer Whales) in 2018 (Cottrell pers. comm. 2019).</p> <p>In US waters, The Soundwatch Boater Education Program, run by The Whale Museum, has been collecting data on vessel interactions with marine mammals since 1993. Since 1998, the number of vessel incidents or violation of regulations has increased, with the most common incidents involving vessels traveling “within 880 m of Lime Kiln Point State Park” or “crossing the path of whales” (Seely et al. 2017).</p>	
R4: protecting TKW from harmful acute and chronic sound exposure	Seismic survey management	Review, develop and implement mitigation measures for all seismic surveys conducted throughout BC TKW range to prevent disturbance or injury	In progress	<p>The 2007 Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP) sets out minimum standard mitigation requirements for seismic survey operations in Canada in an effort to mitigate potential negative population-level impacts on marine wildlife (DFO 2008).</p> <p>In 2015, DFO undertook a study to determine if the mitigation measures</p>	DFO

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				outlined in the SOCP are likely to avoid prohibited impacts on listed cetaceans under the <i>Species at Risk Act</i> (SARA), 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). ¹⁰	
R4: protecting TKW from harmful acute and chronic sound exposure	Sonar management	Continue development and implementation of adequate National Defence sonar protocols to minimize risk of exposure of transients to intense sound sources	In progress	<p>The 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).</p> <p>NOAA Fisheries revised its Technical Guidance for Assessing the Effects of Anthropogenic Noise on Marine Mammal Hearing in 2018 (National Marine Fisheries Service 2018).</p>	DND , DFO, NOAA

¹⁰ 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. Expected publications include a Science Advisory Report, Proceedings, and a Research Document (DFO 2019).

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
R5: determining prey needs	Studies on foraging	Opportunistic prey sampling during dedicated population census surveys	In progress	Prey samples are collected opportunistically during DFO dedicated and opportunistic research excursions. Records from 424 TKW predation events (defined by kills/consumption) were collected between 2013 and 2018. Of these, 367 were observation only and 57 involved tissue sample collection. Of those for which a species ID could be positively assigned (either visually or through genetic analysis), 140 were Harbour Seals, 47 were Harbour Porpoise, 32 were Steller Sea Lions, 10 were Dall's Porpoise, 5 were Pacific White-sided Dolphins, 5 were Common Murres, 3 were Sea Otters and 2 were California Sea Lions. The rest could not be identified or are still awaiting genetic analysis (Doniol-Valcroze pers. comm. 2019).	DFO
R5: determining prey needs	Studies on foraging	Directed surveys to determine diet of TKW in offshore waters	In progress	Offshore research efforts provide increased opportunities for TKW predation observations and prey tissue sampling. However to date, not enough data have been collected to define dietary preference for TKW in offshore habitats (Doniol-Valcroze pers. comm. 2019).	DFO
R5: determining prey needs	Studies on foraging	Population abundance surveys of	In progress	Ship-based DFO cetacean surveys conducted between 2013 and 2018 have recorded habitat use and	DFO, academia

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
		cetacean prey species		<p>presence of cetaceans off the coast of BC. Additionally, in summer 2018, coast wide surveys of cetacean populations were conducted as part of the Pacific Region International Survey of Marine Megafauna (PRISMM) (Doniol-Valcroze pers. comm. 2019). Analyses from the survey are underway, with population estimates for small cetaceans, including Harbour Porpoise, Dall's Porpoise, and Pacific White-sided Dolphins, expected in 2020.</p> <p>Previous estimates of marine mammals in BC waters (including Harbour Porpoise, Dall's Porpoise, Pacific White-sided Dolphin) have been published using data from systematic line-transect surveys conducted between 2004 and 2008 (Best et al. 2015). Williams et al. (2017) published guidance on simple design and field data collection protocols for generating preliminary abundance estimates for coastal marine mammals using small-boat surveys.</p>	
R5: determining prey needs	Studies on foraging	Opportunistic observations through formal and informal	In progress	DFO's Cetacean Research Program continues to maintain the TKW Predation Database. It contains records of 424 predation events (defined by kills/consumption)	DFO

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
		sightings networks		between 2013 and 2018 (Doniol-Valcroze pers. comm. 2019).	
R6: understanding the effects of contaminants and biological pollutants on TKW	Data collection, analysis & modelling	Develop methods to measure the contaminant effects on health of TKW using biopsy	In progress	<p>Biopsy samples have been collected from TKW opportunistically during cetacean research excursions (Doniol-Valcroze pers. comm. 2019). They have been analyzed for PCBs and PBDEs and the data are currently being processed (Noel pers. comm. 2019). Skin of biopsy samples will also be analysed for mercury (Brown pers. comm. 2019).</p> <p>While impacts of contaminants on the health of Resident Killer Whales have been reported (for example, Hall et al. 2018), more research is needed on the effects specific to TKW. Data on contaminant levels in biopsy samples could help to inform such research.</p> <p>Tissue samples from recently dead and non-emaciated TKW have also been collected during necropsies (Cottrell pers. comm. 2019). A standardized necropsy and disease testing protocol was published (Raverty et al. 2014).</p>	DFO, Ocean Wise
R6: understanding the effects of contaminants	Data collection, analysis & modelling	Demographic data exploration to evaluate possible	In progress	Desforges et al. (2018) compiled available data on blubber PCB concentrations in Killer Whales from populations around the world and	Academia

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
and biological pollutants on TKW		population level impacts ¹¹		<p>compared these to established concentration response relationships for reproductive impairment and immunotoxicity-related disease mortality using an individual-based model framework. They found that TKW possess PCB levels above 40 mg/kw lipid weight (10 to 20 fold higher PCB burdens compared to fish-eating Northern Resident Killer Whales) and that this level of exposure is predicted to cause population declines.</p> <p>Hall et al. (2018) developed a model that allows for broad population dynamic predictions to be made for specific populations when estimates of PCB concentrations are known. Estimated population growth rates were affected by the inclusion of effects of PCBs on immunity, although the model was run only for Resident Killer Whales at this time.</p> <p>Jarvela Rosenberger et al. (2017) developed a conceptual framework to evaluate the impacts of potential oil</p>	

¹¹ In 2019, DFO Science developed a cumulative effects framework (building on a previous model for SRKW developed by Lacy et al. 2017) that considered the effects of PCB contaminants in combination with others threats (reduced Chinook Salmon abundance, vessel noise/physical presence, and vessel strike) on the population trajectories of Resident Killer Whales (DFO 2019). These methods could be applicable to a future study for TKW.

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>exposure on marine mammals and applied it to 21 species inhabiting coastal BC. Killer Whale populations were deemed at highest risk due to small population sizes, complex social structure, long lives, slow reproductive turnover, and dietary specialization. Vulnerability was deemed highest for Resident Killer Whales and Sea Otters, followed by TKW and Steller Sea Lions.</p>	
<p>R6: understanding the effects of contaminants and biological pollutants on TKW</p>	<p>Studies on surrogate species</p>	<p>Controlled studies on surrogate species (laboratory animals or other more abundant species such as Harbour Seals) to predict effects of contaminants on TKW</p>	<p>In progress</p>	<p>In collaboration with NOAA, DFO and the Washington State Department of Fish and Wildlife, Ocean Wise collects blubber biopsy samples from Harbour Seals to monitor levels of PBT contaminants including PCBs, PBDEs, and pesticides. The most recent sampling of Harbour Seals occurred in 2018 and samples are currently being processed for PCB, PBDEs, pharmaceuticals, and PFCs (Noel pers. comm. 2019).</p> <p>Recent research by Beckmen et al. (2016) identifies the biomagnification of PCB congeners in tissues of Steller Sea Lions in Alaska, which may have implications for mammal-eating TKWs.</p>	<p>Academia, DFO, NOAA, Ocean Wise, Washington State Department of Fish and Wildlife</p>
<p>R6: understanding</p>	<p>Analysis of existing and</p>	<p>Necropsy, sample</p>	<p>In progress</p>	<p>Blubber samples are collected opportunistically during necropsies</p>	<p>DFO, BC Ministry of</p>

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
the effects of contaminants and biological pollutants on TKW	new necropsy data	collection and analysis of samples		performed on TKWs over the past five years. Samples are stored to allow for future contaminant analyses (Cottrell pers. comm. 2019).	Agriculture, Food and Fisheries, Ocean Wise
R7: understanding vessel disturbance effects	Behavioural studies	Dedicated studies of foraging behaviour and predation rates in the presence of vessels	Not started	No dedicated studies have been conducted to date on foraging behaviour in the presence of vessels.	DFO
R8: understanding the effects of acute and chronic sound exposure	Behavioural studies	Determine effect of high levels of chronic and acute industrial underwater noise on TKW behaviour and foraging success	Not started	With financial support from DFO, 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 three metrics: (1) noise-induced changes in behaviour, physiology and/or health, (2) communication masking, and (3) echolocation masking (Heise et al. 2017). Some of the findings of this workshop could be applicable to TKW, although no dedicated study has been conducted to determine the effect of noise on TKW behaviour and foraging success.	DFO, Ocean Wise
R8: understanding the effects of	Data synthesis	Compile existing data to evaluate the	In progress	The Vancouver Fraser Port Authority-led ECHO Program has undertaken assessments of underwater shipping	ECHO Program , academia,

Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
acute and chronic sound exposure		impact of chronic and acute sound exposure		<p>noise in the Salish Sea and its potential impacts to SRKW, as well as potential means of mitigating noise exposure (Tollit et al. 2017). 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 consultations, Indigenous groups and Canadian and US governments, including representatives from DFO, TC, NOAA, and Canadian and US Coast Guards.</p> <p>The ECHO Program has made progress linking the noise of individual ships to their Automatic Identification System (AIS) information. Similar efforts are also being undertaken through an Innovation Canada-funded pilot study involving Ocean Sonics Ltd and DFO Pacific Marine Mammal Program. This Whale Tracking Network program involves the development of an acoustic detection system for Killer Whales in key areas within the Strait of Georgia. This will involve integration with AIS information on vessel presence and noise (DFO 2017).</p>	DFO, NMES, NOAA, TC

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Objective ³	Broad strategy	Approach	Status	Descriptions and results	Participants ⁴
				<p>Additionally, the Marine Environmental Observation, Prediction and Response Network (MEOPAR)-funded Noise Exposure to Marine Ecosystems from Ships (NMES) project at the University of Victoria is assessing ambient noise in the Salish Sea (Cottrell pers. comm. 2019; DFO 2017).</p>	

3.2 Activities supporting the identification of critical habitat

Table 3 provides information on the implementation of the studies outlined in the schedule of studies to identify critical habitat in 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: the activity is underway and has not concluded¹²
- 3) not started: the activity has been planned but has yet to start
- 4) cancelled: the activity will not be started or completed

Table 3. Status and details of the implementation of the schedule of studies outlined in the recovery strategy.

Description of activity	Outcome/ rationale	Timeline	Status	Descriptions and results	Participants ¹³
Spatial analysis of existing sighting data	To better understand habitat utilization	After one year of posting the final recovery strategy	Completed	A Canadian Science Advisory Secretariat (CSAS) process to provide information in support of the identification of critical habitat for Transient Killer Whales (TKW) was completed in 2013. Based on an archive of photo-identifications of individual TKW collected during 3,582 encounters between 1958 and 2011, they found that TKW are highly mobile and range over the entire BC coast throughout the year and forage on marine mammal prey primarily in close proximity to coastlines. Based on the existing information, it suggests that Pacific coast marine waters within 3 nautical miles (5.56 km) of the nearest shoreline should be considered the habitat necessary	Fisheries and Oceans Canada (DFO)

¹² Many of the activities listed as “in progress” are ongoing with no specific endpoint.

¹³ Lead participant(s) is/are listed on top and in bold; other participants are listed alphabetically.

				to meet the population and distribution objectives described in the recovery strategy (DFO 2013; Ford et al. 2013).	
Spatial analysis of existing data with respect to the distribution of the prey of TKW	To better understand habitat utilization and whether TKW distribution is correlated to prey abundance	After five years of posting the final recovery strategy	Completed	The 2013 CSAS process previously mentioned above, reported on the distribution of TKW in relation to predation (DFO 2013; Ford et al. 2013). The primary prey species of TKW are distributed widely in nearshore waters. TKW are likely vulnerable to local resource depression in foraging locations, whereby prey become alert to whales' presence and less vulnerable to predation. Therefore, TKW tend to move continuously throughout their habitat and do not remain long in particular locations (Ford et al. 2013).	DFO
Spatial analysis of TKW kill locations with respect to ambient noise environment	To determine whether TKW hunting success is influenced by anthropogenic noise	After five years of posting the final recovery strategy	Not started	<p>Spatial analysis of TKW kill locations has not been undertaken with respect to ambient noise environment.</p> <p>Several initiatives are compiling data on ambient noise levels in Canadian Pacific waters including those led by DFO, Vancouver Port Authority-led Enhancing Cetacean Habitat and Observation (ECHO) Program, Environmental Non-Government Organization (ENGOS), Parks Canada (PCA), and university researchers (for example, see Erbe et al. 2014). Future studies could compare these data with TKW kill</p>	DFO, academia ENGOS, PCA, ECHO Program

				locations to assess the effect of anthropogenic noise on hunting success.	
Year-round surveys to determine range and seasonal movements of TKW	To better identify areas of occupancy	After five years of posting the final recovery strategy	In progress	<p>Knowledge of year-round distribution of TKW is informed through multi-species cetacean surveys, acoustic deployments, and sightings reported to informal and formal sighting networks. Monitoring TKW is a collaborative effort by researchers with DFO, ENGOs, PCA, Indigenous groups, industry, National Oceanic and Atmosphere Administration (NOAA), universities, and numerous other contributors (Towers et al. 2019).</p> <p>Burham et al. (2016) deployed a Passive Acoustic Monitoring (PAM) recorder to identify Killer Whale presence during the winter months in Clayoquot Sound, on the west coast of Vancouver Island. Both Resident and TKW were recorded, although analysis of vocalizations determined that the majority of the encounters recorded acoustically were of Northern Resident Killer Whales (NRKW).</p>	DFO , academia ENGOs, Indigenous groups, industry, NOAA, PCA
Year-round surveys to determine the spatial and temporal distribution and	To better understand habitat utilization and whether TKW distribution is	After five years of posting the final recovery strategy	In progress	The presence and location of small cetaceans is recorded during DFO multi-species surveys (including an annual winter survey along the central and north coasts), acoustic deployments, and aerial surveys.	DFO

<p>abundance of small cetaceans</p>	<p>correlated to prey abundance</p>			<p>Twenty aerial surveys were conducted between 2013 and 2015. The target species for these surveys were large cetaceans (Fin Whales, Humpback Whales, Blue Whales), but other cetaceans were noted whenever they were observed (Doniol-Valcroze pers. comm. 2019).</p>	
<p>Formal and informal sightings network for TKW and small cetaceans</p>	<p>Acquire better information on the distribution of TKW prey and how it may influence TKW distribution</p>	<p>After five years of posting the final recovery strategy</p>	<p>In progress</p>	<p>While not survey-based, data on the occurrence of small cetaceans are collected year-round through the BCCSN. These opportunistic sightings reported by coastal citizens, mariners, researchers, agencies, and eco-tourism operators can help yield predictions of small cetacean distributions in BC waters in both winter and summer seasons (Rechsteiner et al. 2013).</p> <p>Hydrophones maintained along the coast by DFO, PCA, Vancouver Fraser Port Authority-led ECHO Program, and ENGOS collect acoustic detections of Killer Whales and other cetaceans (Cottrell pers. comm. 2019). In the United States waters, The Orca Network maintains a database of sightings of cetaceans primarily in the Salish Sea (The Orca Network 2019).</p> <p>Formal and informal sighting networks for TKW and small</p>	<p>DFO, Ocean Wise, ENGOS, PCA, ECHO Program</p>

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				cetaceans are described in more detail in table 2 above (for example, see under objective P1 & P2).	
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3.3 Summary of progress towards recovery

3.3.1 Status of recovery strategy implementation

The recovery strategy for TKW recommended 39 approaches to meet the identified population, distribution and recovery objectives. Progress on these approaches are reported on in table 2. Of these, 35 (90%) are in progress. While significant progress has been made, many of these activities are ongoing with no specific endpoint and therefore are not marked as completed. Activities in support of three approaches (8%) have not yet started, and activities in support of one approach (~3%) has been completed for TKW in Canadian waters.

3.3.2 Completion of action plan

Development of the action plan for TKW is underway. The action plan outlines measures that provide the best chance of achieving the population, distribution, and recovery objectives for the species, including the measures to be taken to address the threats and monitor the recovery of the species.

3.3.3 Critical habitat identification and protection

Critical habitat has yet to be identified for the species. Detailed progress towards identifying critical habitat has been reported on in section 3.2.

3.3.4 Recovery feasibility

As stated in the recovery strategy, the TKW population is unlikely to achieve high abundance due to their ecological position as upper-trophic level predators and propensity to live in small populations (DFO 2007). Ongoing population growth suggest that TKW are not yet at carrying capacity in coastal waters (Towers et al. 2019).

High contaminant burden, disturbance, and the threat of changes to prey availability warrants the protection of SARA prohibitions and the implementation of recovery actions that will address threats so that TKW do not decline to an endangered status. As technologies and methodologies currently exist to reduce many of the threats facing TKW, their prey, and their habitat, recovery is considered feasible (DFO 2007).

4. Concluding statement

Significant progress has been made towards meeting the objectives outlined in the recovery strategy. A new photo identification catalogue has been published, based on a 61-year archive of photo-identification data from 1958 to 2018 (Towers et al. 2019). Ongoing efforts to document and monitor TKW through dedicated cetacean surveys, passive acoustic monitoring, opportunistic effort, and sighting networks provide valuable information on the abundance and distribution of TKW in BC waters. Amendments to the Marine Mammal Regulations under the *Fisheries Act* were implemented in 2018, minimizing disturbance of TKW and their marine mammal prey along the coast. The Marine Mammal Response Program continues to offer direct response to incidents of harassment or entanglement and necropsies help us to better understand the impacts of threats on the health of individuals. Ongoing partnerships with local groups through the Habitat Stewardship Program and the Aboriginal Fund for Species at Risk have provided significant contributions to research, outreach, and education efforts.

- Through initiatives included in the \$1.5B 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 \$167.4M through the Whales Initiative to address main threats to Southern Resident Killer Whales, with direct positive implications for TKW (DFO 2018). Under this initiative, a contaminants working group has increased sampling and monitoring efforts and significant advancements have been made towards understanding population-level impacts of contaminants on Killer Whales. Starting in

2018, the Government of Canada also implemented additional enhanced seasonal management measures to support recovery of Southern Resident Killer Whale (SRKW). These measures started in 2018 with seasonal fishing restrictions, and expanded in 2019 to include interim sanctuary zones, and an increased approach distance for Killer Whales (all ecotypes) to 400 m in areas of SRKW critical habitat (DFO 2020). Voluntary measures were also introduced in 2019 to stop fishing within 1000 m of killer whales, slow down to 7 knots or less when within 1000 m of the nearest marine mammal, turn off echo sounders and fish finders when not in use, and to place engines in neutral idle and allow animals to pass if a vessel is not in compliance with the approach distance regulations. While developed specifically for SRKW, these additional measures have both indirect and direct benefits for TKW. Additionally, ongoing transboundary initiatives such as the 2017 to 2020 Salish Sea Action Plan reinforce the commitment to strengthening information exchange and developing a streamlined approach for addressing threats to a shared watershed (ECCC & EPA 2017).

As TKW is a long-lived species with low reproductive rates, the effects of recovery efforts can be expected to take multiple generations to be realized. Since 2012, the subset of TKW individuals that are most often observed in coastal BC waters has grown at an observed average annual rate of 4.1% due to relatively low mortality and the birth of over 100 calves during this time period (Towers et al. 2019). Continued work, including research and conservation efforts, is required to address the threats to TKW. Fisheries and Oceans Canada and Parks Canada maintain an ongoing commitment toward the recovery of this population.

5. References

Alava, J.J., D. Lambourn, P. Olesiuk, M. Lance, S.J. Jeffries, F.A.P.C. Gobas, and P.S. Ross. 2012. PBDE flame retardants and PCBs in migrating Steller sea lions (*Eumetopias jubatus*) in the Strait of Georgia, British Columbia, Canada. *Chemosphere* 88(7): 855–864.

Alava, J.J., P.S. Ross, and F.A.P.C. Gobas. 2016. Food web bioaccumulation model for Resident Killer Whales from the northeastern Pacific Ocean as a tool for the derivation of PBDE-sediment quality guidelines. *Archives of Environmental Contamination and Toxicology* 70(1): 155–168.

Barrett-Lennard, L, pers. comm. 2019. Email correspondence with A. Biega. September 2019. Director, Marine Mammal Research Program, Ocean Wise, Vancouver, BC.

Be Whale Wise. 2019. [Be Whale Wise](#). Accessed: 23 September 2019.

Beckmen, K.B., M.J. Keogh, K.A. Burek-Huntington, G.M. Ylitalo, B.S. Fadely, and K.W. Pitcher. 2016. Organochlorine contaminant concentrations in multiple tissues of free-ranging Steller sea lions (*Eumetopias jubatus*) in Alaska. *Science of the Total Environment* 542: 441–452.

Best, B.D., C.H. Fox, R. Williams, P.N. Halpin, and P.C. Paquet. 2015. Updated marine mammal distribution and abundance estimates in British Columbia. *Journal of Cetacean Research and Management* 15: 9-26.

British Columbia Ministry of Environment and Climate Change Strategy. 2019. Derivation of Water Quality Guidelines for the Protection of Aquatic Life in British Columbia. Water Quality Guideline Series, WQG-06. Province of British Columbia, Victoria, BC.

Brown, T., pers. comm. 2019. Email correspondence with A. Biega. September 2019. Research Scientist, Fisheries and Oceans Canada, West Vancouver, BC.

Burham, R.E., R.S. Palm, D.A. Duffus, X. Mouy, and A. Riera. 2016. The combined use of visual and acoustic data collection techniques for winter killer whale (*Orcinus orca*) observations. *Global Ecology Conservation* 8: 24–30.

Canadian Water Network. 2018. [Canada's challenges and opportunities to address contaminants in wastewater](#). National Expert Panel Report Synopsis. Accessed 7 November 2019.

Cardinal, N., pers. comm. 2019. Email correspondence with A. Biega. September 2019. Resource Conservation Manager, Parks Canada, Sidney, BC.

Carretta, J.V., V. Helker, M.M. Muto, J. Greenman, K. Wilkinson, D. Lawson, J. Viezbicke, and J. Jannot. 2018. Sources of human-related injury and mortality for U.S. Pacific west coast marine mammal stock assessments, 2012–2016. NOAA Technical Memorandum NMFS-SWFSC-601.

Cauffopé, G., pers. comm. 2019. Email correspondence with L. Jones. November 2019. Chief, Regulations and Policy, Conservation and Protection, Fisheries and Oceans Canada, Vancouver, BC.

Cetus Research and Conservation Society. 2019. [Straitwatch](#). Accessed 5 September 2019.

City of Vancouver. 2019. [Street drainage and catch basins](#). Accessed 28 August 2019.

Coastal First Nations. 2019. [Coastal Guardian Watchmen](#). Accessed 5 September 2019.

Coastal Ocean Research Institute. 2016. Mariner's Guide to Whales, Dolphins, and Porpoises of Western Canada. Vancouver, BC. 60 pp.

Community Mapping Network. 2016. [Pacific Region Contaminants Atlas](#). Accessed 29 August 2019.

COSEWIC. 2001. COSEWIC assessment and status report on the killer whale *Orcinus orca* populations in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 47 pp.

COSEWIC. 2008. COSEWIC assessment and update status report on the killer whale *Orcinus orca* populations in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. viii + 65

COSEWIC. 2013. COSEWIC assessment and status report on the Steller Sea Lion *Eumetopias jubatus* in Canada. Ottawa. xi + 54 pp.

Cottrell, P., pers. comm. 2019. Correspondence with A. Biega. September 2019. Marine Mammal Coordinator, Marine Mammal Response Program, Fisheries and Oceans Canada, Vancouver, BC.

Desforges, J.P., A. Hall, B. McConnell, A. Rosing-Asvid, J.L. Barber, A. Brownlow, S. De Guise, I. Eulaers, P.D. Jepson, R.J. Letcher, M. Levin, P.S. Ross, F. Samarra, G. Víkingson, C. Sonne, and R. Dietz. 2018. Predicting global killer whale population collapse from PCB pollution. *Science* 361: 1373–1376.

DFO. 2007. Recovery Strategy for the Transient Killer Whale (*Orcinus orca*) in Canada. *Species at Risk Act* Recovery Strategy Series. Fisheries and Oceans Canada, Vancouver, vi + 46 pp.

DFO. 2008. [Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment](#). Accessed 6 September 2019.

DFO. 2013. [Policy on Managing Bycatch](#). Sustainable Fisheries Framework. Accessed 26 November 2019.

DFO. 2013. Information in Support of the Identification of Critical Habitat for Transient Killer Whales (*Orcinus orca*) off the West Coast of Canada. DFO Canadian Science Advisory Secretariat Science Advisory Report. 2013/025.

DFO. 2015. Report on the Progress of Recovery Strategy Implementation for the Transient Killer Whale (*Orcinus orca*) in Canada for the Period 2007–2012. *Species at Risk Act* Recovery Strategy Report Series. Fisheries and Oceans Canada, Ottawa. v + 19 pp.

Report on the Progress of Recovery Strategy Implementation for the Transient Killer Whale in Canada 2020

DFO. 2017. [Southern Resident Killer Whales: A Science Based Review of Recovery Actions for Three At-Risk Whale Populations](#). Assessed 3 March 2020.

DFO. 2018. [Marine Mammal Regulations Règlement sur les mammifères marins](#). Accessed 26 November 2019.

DFO. 2018. [Whales Initiative: Protecting the Southern Resident Killer Whale](#). Accessed 9 September 2019.

DFO. 2019. Cumulative Effects Assessment for Northern and Southern Resident Killer Whale (*Orcinus Orca*) Populations in the Northeast Pacific. DFO Canadian Science Advisory Secretariat Science Advisory Report. 2019/030.

DFO. 2019. [Review of the Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment](#). Accessed 6 September 2019.

DFO. 2020. [2020 management measures to protect Southern Resident killer whales](#). Accessed 3 December 2020.

Dombowsky, M., pers. comm. 2019. Email correspondence with A. Biega. October 2019. Executive Director, Cetus Research and Conservation Society, Victoria, BC.

Doniol-Valcroze, T., pers. comm. 2019. Email and telephone correspondence with A. Biega. September 2019. Research Biologist, Fisheries and Oceans Canada, Nanaimo, BC.

ECCC and EPA. 2017. [Canada - U.S. Cooperation in the Salish Sea: 2017–20 Action Plan](#). Accessed 26 November 2019.

EPA. 2019. [Toxics in the Food Web: Pacific Herring and Harbor Seals](#). Accessed 28 August 2019.

Erbe, C., R. Williams, D. Sandilands, and E. Ashe. 2014. [Identifying modeled ship noise hotspots for marine mammals of Canada's pacific region](#). PLoS ONE 9(3): e89820.

Ford, J.K.B., E.H. Stredulinsky, J.R. Towers, and G.M. Ellis. 2013. Information in Support of the Identification of Critical Habitat for Transient Killer Whales (*Orcinus orca*) off the West Coast of Canada. DFO Canadian Science Advisory Secretariat Research Document. 2012/155. iv + 46 p.

Ford, J.K.B., G.M. Ellis, and J.W. Durban. 2009. Recovery Potential Assessment for West Coast Transient Killer Whales. DFO Canadian Science Advisory Secretariat Science Advisory Report. 2009/039.

Georgia Strait Alliance. 2019. [ToxicSmart](#). Accessed 28 August 2019.

Government of Canada. 1999. [Canadian Environmental Protection Act, 1999](#). Accessed 26 November 2019.

Government of Canada. 2015a. [PCB Regulations SOR/2008-273](#). Accessed 26 November 2019.

Report on the Progress of Recovery Strategy Implementation for the Transient Killer Whale in Canada 2020

Government of Canada. 2015b. [Wastewater Systems Effluent Regulations SOR/2012-139](#). Accessed 26 November 2019.

Government of Canada. 2016. [Chemicals Management Plan](#). Accessed 26 November 2019.

Government of Canada. 2017. [Southern Resident Killer Whale Symposium: What We Heard Report](#). Vancouver, BC. Accessed 26 November 2019.

Government of Canada. 2018. [Consultation Document on Proposed Amendments to the Prohibition of Certain Toxic Substances Regulations, 2012 for PFOS, PFOA, LC-PFCAs, HBCD, PBDEs, DP and DBDPE](#). Accessed 26 November 2019.

Government of Canada. 2020. [Reducing the threat of contaminants to Southern Resident Killer Whales](#). Accessed 3 December 2020.

Hall, A.J., O.I. Kalantzi and G.O. Thomas. 2003. Polybrominated diphenyl ethers (PBDEs) in grey seals during their first year of life—are they thyroid hormone endocrine disruptors? *Environmental Pollution* 126: 29–37.

Hall, A.J., B.J. McConnell, L.H. Schwacke, G.M. Ylitalo, R. Williams, and T.K. Rowles. 2018. Predicting the effects of polychlorinated biphenyls on cetacean populations through impacts on immunity and calf survival. *Environmental Pollution* 233: 407–418.

Heise, K., L. Barrett-Lennard, R. Chapman, T. Dakin, C. Erbe, D. Hannay, N. Merchant, J. Pilkington, S. Thornton, D. Tollit, S. Vagle, V. Veirs, V. Vergara, J. Wood, B. Wright, and H. Yurk. 2017. [Proposed metrics for the management of underwater noise for Southern Resident Killer Whales](#). *Coastal Ocean Report Series* 2017(2): 31.

Jarvela Rosenberger, A.L., M. MacDuffee, A.G.J. Rosenberger, and P.S. Ross. 2017. [Oil spills and marine mammals in British Columbia, Canada: development and application of a risk-based conceptual framework](#). *Archives of Environmental Contamination and Toxicology* 73(1): 131–153. Springer US.

Johannessen, S.C., R.W. Macdonald, B. Burd, A. van Roodselaar, and S. Bertold. 2015. Local environmental conditions determine the footprint of municipal effluent in coastal waters: A case study in the Strait of Georgia, British Columbia. *Science of the Total Environment* 508: 228–239.

Lacy, R.C., R. Williams, E. Ashe, K.C. Balcomb III, L.J.N. Brent, C.W. Clark, D.P. Croft, D.A. Giles, M. MacDuffee, and P.C. Paquet. 2017. Evaluating anthropogenic threats to endangered killer whales to inform effective recovery plans. *Scientific Reports* 7(1):14119.

Lee, L., pers. comm. 2019. Email correspondence with A. Biega. September 2019. Marine Ecologist, Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve and Haida Heritage Site, Parks Canada, Skidegate, BC.

Lee, L., pers. comm. 2020. Written review of draft Progress Report for TKW 2013-18 via email to Diane Casimir, Parks Canada. February 2020. Marine Ecologist, Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve and Haida Heritage Site, Parks Canada, Skidegate, BC.

MacGillivray, A.O., Z. Li, D.E. Hannay, K.B. Trounce, and O.M. Robinson. 2019. Slowing deep-sea commercial vessels reduces underwater radiated noise. *The Journal of the Acoustical Society of America* 146(1): 340-351.

Majewski, S., pers. comm. 2019. Email correspondence with A. Biega. September 2019. Research Biologist, Fisheries and Oceans Canada, Nanaimo, BC.

McKay, M., pers. comm. 2019. Email correspondence with L. Jones. November 2019. Executive Director; Legislative, Regulatory and International Affairs; Marine Safety and Security, Transport Canada, Ottawa, ON.

Matkin, C.O., M.J. Moore, and F.M. Gulland. 2017. Review of recent research on Southern Resident Killer Whales to detect evidence of poor body condition in the population. Independent Science Panel Report to the SeaDoc Society. 3 pp. + Appendices. DOI 10.1575/1912/8803.

MERS. 2019. [Marine Education and Research Society](#). Accessed 5 September 2019.

Moors-Murphy, H.B., and J.A. Theriault. 2017. Review of Mitigation Measures for Cetacean Species at Risk During Seismic Survey Operations. DFO Canadian Science Advisory Secretariat Research Document. 2017/008. vi + 38 p.

National Marine Fisheries Service. 2018. 2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0). NOAA Technical Memorandum NMFS-OPR-59.

Noel, M., pers. comm. 2019. Email correspondence with A. Biega. September 2019. Research Manager, Ocean Wise, Vancouver, British Columbia.

North Island Marine Mammal Stewardship Association. 2019. [NIMMSA Code of Conduct](#). Accessed 5 September 2019.

Ocean Wise. 2019. [PollutionTracker](#). Accessed 29 August 2019.

Olesiuk, P.F. 2018. Abundance of Steller sea lions (*Eumetopias jubatus*) in British Columbia. DFO Canadian Science Advisory Secretariat Research Document. 2018/006: v + 67 p.

OrcaLab. 2019. [OrcaLab](#). Accessed 28 August 2019.

Pacific Whale Watch Association. 2019. [Whale Watching Guidelines](#). Accessed 5 September 2019.

Parks Canada Agency. 2016. Multi-species Action Plan for Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, and Haida Heritage Site. In *Species at Risk Act* Action Plan Series, vi+. Ottawa.

Porpoise Conservation Society. 2019. [Porpoise Conservation Society](#). Accessed 5 September 2019.

PSEMP Toxics Work Group. 2019. [2018 Salish Sea Toxics Monitoring Synthesis: A Selection of Research](#). C.A. James, R. Jordan, M. Langness, J. Lanksbury, D. Lester, S. O'Neill, K. Song,

and C. Sullivan, eds. Puget Sound Ecosystem Monitoring Program. Tacoma, WA. Accessed 26 November 2019.

Raverty, S.A., J.K. Gaydos, and J.A. St. Leger. 2014. [Killer Whale necropsy and disease testing protocol](#). Accessed 26 November 2019.

Rechsteiner, E.U., C.F.C. Birdsall, D. Sandilands, I.U. Smith, A.V. Phillips, and L.G. Barrett-Lennard. 2013. Quantifying observer effort for opportunistically-collected wildlife sightings. Cetacean Research Lab. 49 pp.

Seely, E., R.W. Osborne, K. Koski, and S. Larson. 2017. [Soundwatch: Eighteen years of monitoring whale watch vessel activities in the Salish Sea](#). PLoS One 12(12): 1–19.

Southern Resident Orca Task Force. 2018. [Southern Resident Orca Task Force Report and Recommendations](#). Accessed 26 November 2019.

Stone, A. 2014. Polychlorinated Biphenyls (PCBs) in General Consumer Products. State of Washington Department of Ecology. Publication No. 14-04-035. Olympia, Washington.

Strawberry Isle Marine Research Society. 2019. [Bigg's Killer Whale Monitoring Project](#). Accessed 30 September 2019.

The B.C. Cetacean Sightings Network. 2018. [The Whale Report Alert System](#). Accessed 28 August 2019.

The Orca Network. 2019. [Sightings](#). Accessed 28 August 2019.

Tollit, D., R. Joy, and J. Wood. 2017. Estimating the effects of noise from commercial vessels and whale watch boats on Southern Resident Killer Whales. Prepared by SMRU Consulting North America for the ECHO Program of Vancouver Fraser Port Authority. Vancouver, BC.

Towers, J.R., G.J. Sutton, T.J.H. Shaw, M. Malleson, D. Matkin, B. Gisborne, J. Forde, D. Ellifrit, G.M. Ellis, J.K.B. Ford, and T. Doniol-Valcroze. 2019. Photo-identification catalogue, population status, and distribution of Bigg's Killer Whales known from coastal waters of British Columbia, Canada. Canadian Technical Report of Fisheries and Aquatic Sciences 3311: vi + 299 p.

Trout Unlimited Canada. 2019. [Yellow Fish Road](#). Accessed 28 August 2019.

Vagle, S. 2020. Evaluation of the efficacy of the Juan de Fuca lateral displacement trial and Swiftsure Bank plus Swanson Channel interim sanctuary zones, 2019. Canadian Technical Report of Hydrography and Ocean Sciences 332: vi + 60 p.

Williams, R., E. Ashe, K. Gaut, R. Gryba, J.E. Moore, E. Rexstad, D. Sandilands, J. Steventon, and R.R. Reeves. 2017. Animal counting toolkit: a practical guide to small-boat surveys for estimating abundance of coastal marine mammals. *Endangered Species Research* 34:149-165.

Yakimishyn, J., pers. comm. 2019. Email correspondence with A. Biega. September 2019. Marine Ecologist, Pacific Rim National Park Reserve of Canada, Parks Canada Agency, Ucluelet, BC.